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SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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DESIRABLE PRODUCT FROM THE TEACHER OF MATHEMATICS—THE POINT OF VIEW OF AN ENGINEERING TEACHER.[1]

THE school curriculum of to-day lies under the charge, vigorously pressed at the hands of many, of leaning to fads and being given over to poor teaching. The teaching of only two subjects seems to be excepted from the general charge of incompetency that is often made—namely, Latin and mathematics—and I have sometimes reflected upon the meaning and propriety of the exceptions. Returning to these reflections when your courteous secretary invited me to address you, I determined to lead you over some of this ground—old and often trod ground you may say—but nevertheless it is ground well worthy of surveying again and even again.

I think the charge of fads grows partly or wholly out of the character of work done in the kindergartens—under which name numerous sins are often cloaked by well meaning, accomplished, but highly impractical, and often incompetent, teachers. I am an earnest believer in the purposes of the kindergarten, but the practical results of its operation, where I have observed it, seem often to disseminate faulty methods of observation, poor workmanship in handicrafts and inaccuracy in thought. It is suggested that the pure kindergarten methods have their most important place in connection with the schools of social set-

[1] An address delivered before the general session of the Central Association of Science and Mathematics Teachers, November 25, 1904.

tlements and their like, which are found in the most densely settled portions of cities, and which have to do with children who find little or none of the gentle or softening influences of the average American home. These methods certainly bring a minimum of good to children of whom reasonable obedience and courteous bearing are expected in their home life.

To the kindergarten belongs the initial work of manual training. By that often abused phrase I particularly mean geometrical drawing and instruction in handicrafts of various kinds. Indeed, a relatively large proportion of the kindergarten pupil's time ought to be engrossed by manual training, because the brain is then specially amenable to training in the precise control of the senses; and this manual training ought to be carried up through the grades in the elementary schools with gradually decreasing allotment of time until it is nearly (or even entirely) succeeded by purely mental studies when the high school is reached. All that is now done with manual training in the high schools can be better done in the lower schools. But brains can be as easily produced by wishing, as precision of thought and act can be produced by an untrained teacher.

There is the rub in the situation. Poorly taught manual training is particularly dangerous because it encourages lack of precision in perception, performance and judgment, at the very time in his development when the habit of slovenly inaccuracy is most readily impressed upon the pupil. Less harm from poor teaching in this branch results in the high school than in the kindergarten, because the older child is less readily and less permanently affected by slovenly processes, if he has previously been under wise instruction. Also, better teachers, with reasonably good training, are available for the high school teaching of manual training, because better wages are there afforded. How can we expect—who should expect—accuracy of observation, precision of act and accuracy of thought to be inculcated in small children by a young woman who possesses not one of those important attributes herself, and who has never learned that they are important—indeed, essential—to the highest success in man or woman?

Gentlemen of the secondary schools, if you will lend your attention judiciously to reforming the schools below yours, and will really produce the reformation, you will be relieved of that disconcerting and mischievous pressure that is now directed towards securing for manual training a considerable portion of the time of the secondary school curriculum which is now occupied by what are commonly called disciplinary studies.

A few of the better universities acknowledge that a small amount of manual training is appropriate to the list of entrance requirements, and such an acknowledgment is quite usual by the engineering colleges (the University of Wisconsin admits not to exceed one unit out of the fourteen units of high school work accepted for entrance into engineering courses). Such a proportion is substantially as much as ought to be made a part of the high school curriculum, but it ought to be only the final capping of a stout pyramid of drawing and handicrafts which has its capacious lower leaf in the primary school or kindergarten. In this connection, let me say that much confusion exists in the minds of many regarding the relations of trades schools to high schools and of trades schools to university courses in engineering. Each of these has its own place, and they should not be confused.

Precision of observation, accuracy of execution and clear reasoning are necessary

to the best endeavor in all disciplinary studies, but particularly in mathematics. These attributes may be built up with peculiar success when the aid of rightly conceived and *wisely taught* manual training is invoked during the tender years of the pupil. But even when these attributes are possessed by all of your pupils, the fullest success in teaching mathematics will still demand a fixed purpose and high pedagogical ideals in the teacher, added to a sympathetic knowledge of his subject.

A *man* is a creature who honestly brings his undertakings to accurate results, even though the method adopted may not be the simplest or the one approved by academic authority. This requires an open mind, keen observation, analytical thinking and accurate powers of inference.

A parrot might glibly recite the rules for following an approved method, and then defend inaccurate results by the plea of carelessness, or haste in the particular instance.

The *man* may not know the rules as they are phrased in the books, but an inaccurate result is (for him) a matter of real chagrin and humiliation.

As the pupils now come to the colleges (perhaps I should refer more particularly to engineering colleges, as with them my experience more particularly lies) from the secondary schools, they ordinarily possess little power of clear thinking, power of initiative, regard for accuracy, or understanding of continuous intellectual effort. It is true that they are not yet mature in either body or mind, and too much should not be expected of them. But it is also true that their preparatory schooling has left them with a defective acquaintance with the construction of the English language and the spelling of English words, a still more defective acquaintance with French or German or a fairly good grounding in elementary Latin, a smattering of civics and history, a training in the elementary principles of arithmetic, geometry and algebra, *from which the factor of accuracy in application has often been omitted,* and perhaps an enthusiastic though often misguided interest in the physical sciences.

I do not wish you to think of me as reflecting on the industry of the secondary school teachers. The facts are as I have stated them, but I can truthfully say that, considering all of the conditions, there is probably no more painstaking and right wishing body of people than these teachers. It is the conditions that are not right. The schools encourage, as Herbert Spencer says, '*submissive receptivity* instead of *independent activity.*' The unfortunate situation is, perhaps, a result of the inexperience of school boards, or the inexperience, inadequate compensation or improper training of a large proportion of the teachers, or the crowding of the schools may overwork and cramp the best of teachers.

Many of the faults in the secondary school training (which has been the lot of students entering our engineering colleges) may be caused by a doubt that has recently seemed to unsettle certain educational circles on account of the question whether high schools shall be the 'people's colleges,' or remain in the station of secondary schools. This doubt is apparently not yet resolved in the minds of those who undertake to mold educational thought in the secondary schools; but the traditional old time secondary school training which produced men who could spell and cipher and who had received a thorough and accurate drill in at least one language is certainly to be given foremost place as a preparation for a college course. In my estimation, when accompanied with history and a year spent in civics and natural sci-

ence, it is not only an advantageous school course for preparing students for college, but it is a preferable course for those numerous young people who can not go through college.

Many of the errors of teaching in the universities are the result of an undiscriminating chasing after the popular cry, and many spurious pedagogical ideas are still propagated which were long since laid by the competent leaders. I presume that the same condition is found in the secondary schools. What engineering teacher can do his duty who does not understand the truly simple relation between theory and practice, and where can he find it better expressed than when reading the inaugural dissertation of Professor Rankine? What secondary school teacher can teach his best, whatever may be his instinctive capacity, who has not read Montaigne's essays on teaching or Spencer's little book on education, or who has not absorbed the point of view of some of the great teachers through adequate biographies?

Of the elementary mathematics taught in the schools, I have just said that the factor of accuracy in application is often omitted, or, if it is not actually omitted, it is largely neglected.

Contact with men entering college shows that:

The arithmetic class is taught the rules, but not the reasoning upon which the rules are founded or the overshadowing importance of impeccable accuracy in numerical results.

The algebra class is taught to transform (or, as I may call it, juggle) equations, but little thought is bestowed where the greatest thought belongs—that is, to the physical meaning of each form that is produced. This fault, I must admit, is not missing from the universities, and is propagated in the schools by association.

The geometry class is apparently taught by rote, and even where a show is made of encouraging the originality of the pupils it is likely to be more an illusion than a fact.

Large classes encourage teaching for the average mass, rather than the stirring of each individual as must be done to create the fullest results. Apparently in few mathematics classes are the pupils taught to scrutinize and check the results of their labors by means appealing more to the common sense than to cut and dried methods. Many years of observation with college students have shown me that the attention of secondary school pupils is seldom drawn to such useful processes for checking numerical results (which were taught with fidelity to our fathers) as 'casting out the nines'; and the worst of it is that the pupils have not been taught even the simple philosophy of our decimal system which might enable them to work out the processes for themselves.

If the causes that contribute to allow the pupils to reach the end of the secondary school training with their originality sleeping, their normal sense of accuracy lost and their best accomplishment in mathematics a parrot-like following of hackneyed method in familiar problems—if the causes from which these conditions spring are anchored in overcrowded classes, then it is your duty and privilege to cry aloud for more air, more breath of life, more chance to teach each living individual instead of the average of an inert class.

Mathematics is a tool—a powerful system of logic, an aid to reasoning—which confers power and advantage on the individual in proportion to the fullness of his possession. The value of mental discipline obtained while accomplishing that possession is inestimable. And the teacher's aim ought to be to make that possession most

complete in those respects which stimulate the powers of accurate (straight) reasoning.

It has seemed to me that the present teaching of mathematics is not so effective as that brought to bear on my generation in the secondary schools, and it likewise appears to me that my generation was less effectively taught to reason, through mathematics, than was my father and his generation.

I am not a reactionary or one who exalts the past above the present. But I see a reason for the present condition in the extended introduction of analytical mathematics and a consequent relegation of constructive mathematics to a minor place. The introduction of the analytical mathematics is not of itself to be regretted, but it seems to have brought with it a change in the method of teaching which is profoundly unfortunate. The teacher now feels under requirement to lead a large class over certain ground in a given time, and (to use the concrete example of algebra) he finds he may do so by expecting the students to learn the processes by the book, and solve the equations, but he has no time (nor strength, if the class is unduly large) to spend in the work which is really of overshadowing importance—that is, drilling the students to interpret the physical meaning of each pregnant transformation.

Unhappily this condition has had the support of the science departments (especially of mathematics and physics) in some of our great universities, where it has been held that the equation is the thing and the interpretation of minor moment; and with this support in high quarters, how should we expect the stupefying mechanical method to be banished from the secondary schools.

But, gentlemen, *the equation is not the thing.* The interpretation of the equation —an understanding of the real meaning of transformations, and a grasp of the relations of things, which lead to sound reasoning—is the feature of first importance to be derived from the study of mathematics.

The mental subsoil is stirred in developing physical conceptions of the relations of things, while even the sod may not be well broken in learning the processes of juggling equations. Stirring the mental depths often calls for the exertion of the utmost powers of good teaching, but poor teaching is inexcusable, unless, much easier as it is, it may be exacted by the undermanned and overcrowded conditions of some of our schools.

What constitute first-rate instincts in a teacher of mathematics may be illustrated by an anecdote:

Some years ago a mature graduate student who was in one of my college classes asked me if it would not be better to go slower at some places so that the class should *thoroughly understand the relations of things,* even if we did not cover the whole subject in the allotted time. This was text-book work and in an engineering subject of analytical character. We were then covering only ten or twelve duodecimo pages per day, but the book was one in which nearly every sentence was charged with important meaning and each mathematical expression, however simple or complicated, represented some important physical relations.

The student had been a college instructor with a fine reputation as a teacher of mathematics or mechanics, and since then he has become a professor of engineering. I have understood that he has strongly entrenched his reputation as a man whose students become young men of discreet thought, notable for resourcefulness and character.

What we need from the mathematics teacher is, not for them to produce young men who can juggle equations, but to produce young men who can recognize the relations of things.

My limit of time is presumably exhausted, and I will conclude. You probably will not all now agree with my opinions, but fair opinions honestly spoken ought to offend no one; and I am satisfied that my opinions will be sustained in the minds of the majority of experienced teachers in engineering colleges who have given careful thought to the question before us. When the University of Wisconsin puts into effect a year hence its promulgated additional requirements in algebra preparation for students entering the college of engineering, it is not so much because we particularly care for more pages of the book to be covered in the high schools, but because we hope that the students (with more time allotted to the subject) may attain more of the true powers of reasoning that come from searching for and recognizing the relations of things.

If a teacher's pupils are capable of transforming (juggling) equations correctly according to rule, without giving a thought to the meaning of the forms produced, or are capable of following through an arithmetical problem by the approved method without considering the reasonable accuracy of the numerical results, then that teacher's sowing has been choked with tares. But a teacher of mathematics who leads his pupils to give due thought in the course of their work to interpreting equations, to noticing the relations of things, and to scrutinizing and checking the accuracy of every numerical result (even though the pupils may evolve, for their own use, awkward and unapproved analytical methods)—that teacher's sowing is of golden wheat.

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THEORIES OF METABOLISM.[1]

THE sum of the chemical changes which take place within the organism under the influence of living cells is called metabolism. This paper is to discuss the character of these changes and to consider, as far as we may, their cause.

It was Lavoisier who first understood that oxygen supported combustion and he compared life with the flame of a candle. He conceived the idea that hydrogen and carbon were brought to the lungs by the blood and there united with oxygen. It was, however, observed that the heat production was not confined to the lungs, and when Magnus found that venous blood was richer in carbon dioxide and poorer in oxygen than was arterial blood, the process of oxidation was placed in the blood. Ludwig in his later years believed this. The prevailing view, however, is that the processes of metabolism take place within the cells of the body.

Lavoisier believed that oxygen was the cause of the metabolism. Liebig thought that fat and carbohydrates were destroyed by oxygen, while proteid metabolism took place on account of muscle work. Voit showed that muscle work did not increase proteid metabolism and that the metabolism was not proportional to the oxygen supply. The amount of oxygen absorbed apparently depended upon what metabolized in the cells. He showed that although fat burned readily in the air, it burned only with great difficulty in the body; and that proteid burned with comparative difficulty in the air, but went to pieces very readily in the body. Voit believed that the cause

[1] A paper read before the New York Section of the American Chemical Society.

of metabolism was unknown, but that the process was one of cleavage of the food molecules into simpler products which could then unite with oxygen. Yeast cells, for example, convert sugar into carbon dioxide and alcohol without the intervention of oxygen. In like manner the first products of the decomposition of fat, sugar and proteid are formed in metabolism through unknown causes. Some of these preliminary decomposition substances may unite with oxygen to form carbon dioxide and water, others may be converted into urea, while others under given circumstances may be synthesized to higher compounds. In any case the absorption of oxygen does not cause metabolism, but rather the amount of the metabolism determines the amount of oxygen to be absorbed.

The statement is frequently met with in the literature of the subject that such and such a disease is the consequence of deficient oxidation power in the tissues. For example, it has recently been stated that alcohol decreases the oxidation power of the liver for uric acid. Such apparent decrease in oxidation power may be due to the fact that the protoplasm is so altered that the normal oxidizable cleavage products of uric acid are not formed and, therefore, no oxidation can take place. It is not due to lack of oxygen that sugar does not burn in diabetes, or cystin in cystinuria. There is the normal supply of oxygen present, but the cleavage of these substances into bodies which can unite with oxygen can not be effected, and hence they can not burn.

There is a difference of opinion as to whether the food substances must first become vital integers of the living cell, or whether the non-living food materials are metabolized without ever becoming a constituent part of the living protoplasm.

Pflüger holds the former view that incorporation of nutritive matter with the living substance is essential to its metabolism. He conceives that living proteid may contain the labile cyanogen group in contrast with dead proteid which contains the amino group. He illustrates this by Wöhler's classic experiment of the easy conversion of ammonium cyanate into urea.

$$NH_4OCN = (NH_2)_2CO$$

Voit's theory is that the living proteid is comparatively stable and that food proteid which becomes the circulating proteid of the blood is carried to the cells and promptly metabolized. The other foodstuffs are also burned without first entering into the composition of the cell.

A mass of living cells composing the substance of a warm-blooded animal has the same requirement of energy as any similar mass of living cells composing the substance of any other animal of the same size and shape. The reason for the metabolism lies in unknown causes within the cells. Liebig conceived the cause to be due to the swinging motion of the small constituent particles of the cells themselves. If this hypothesis be accepted the vibrations of the cells may be assumed to shatter the proteid molecule into fragments consisting of amino bodies, and to break down fat and sugar into substances of a lower order than themselves.

The uniformity of the energy requirement is illustrated by the following table showing the number of calories given off during the twenty-four hours by one square meter of surface in various animals and in man, in the condition of starvation.

	Weight in kilos.	Cal per sq. m. Surface.
Man	64	1042
Pig	128	1078
Dog	15	1039
Mouse	0.018	1188
Diabetic man	54	925

This illustrates Rubner's law of skin area, which holds that the metabolism is

proportional to the exposed area of the animal.

Even in pathological conditions a remarkable constancy of total heat production is apparent. Thus in such typical disturbances as anæmia, diabetes, gout and obesity, the general laws governing the output of carbon dioxide, the absorption of oxygen and the production of heat are found to be the same as in health. In fever the metabolism and heat production increase and this to a certain extent on account of the warming of the cells. In exophthalmic goiter there is probably an increase in metabolism, due to the chemical stimulus of an excessive production of iodothyrin in the thyroid gland, while in myxœdema the absence of the same substance causes a considerable reduction in the metabolism. Drugs may influence the course of the metabolism, iodothyrin increasing it and morphine profoundly diminishing it, but on the whole the most striking fact is not the variability, but rather the uniformity, of the processes concerned.

Within recent years the work of Kossel, Fischer, Hofmeister and Levene has given a more definite conception of the composition of proteid than was before possible. There is every indication that the proteid molecule consists fundamentally of groups of amino fatty acids banded together. Proteids vary with the integral components of their chemical chains. It has long been known that the end products of tryptic digestion include such substances, but Kutscher first showed that continued tryptic digestion resulted in the complete transformation of proteid into these amino-acids. Cohnheim discovered erepsin, an enzyme derived from the intestinal wall, which rapidly converts albumoses into these substances.

On chemical analysis, using methods developed in Emil Fischer's laboratory, the cleavage products of various proteids appear distributed as shown in the following table.[2]

COMPOSITION OF PROTEID.

	Casein.	Gelatin.	Elastin.	Globin from Hæmaglobin.	Edestin.
Glycocoll	0	16.5	25.75	0	3.8
Alanin	0.9	0.8	0.58	4.19	3.6
Leucin	10.5	2.1	21.38	29.04	20.9
Pyrrolidin carboxylic acid	3.1	5.1	1.74	2.34	1.7
Phenylalanin	3.2	0.4	3.89	4.24	2.4
Glutamic acid	10.7	0.88	0.76	1.73	6.3
Aspartic acid	1.2	0.56	—	4.43	4.5
Cystin	0.065	—	1.0	0.31	0.25
Serin	0.23	—	—	0.56	0.33
Oxy-γ-Pyrrolidin carboxylic acid	0.25	3.0	—	1.04	2.0
Tyrosin	4.5	—	0.34	1.33	2.13
Anninovalerianic acid	1.0	—	—	—	*
Lysin	5.80	2.75	—	4.28	2.0
Histidin	2.59	7.62	—	10.90	1.0
Arginin	4.84	0.40	0.3	5.42	11.7
Tryptophan.	1.5	—	—	*	*

* Present.

The proteid metabolism in plants and animals occurs in striking similarity to the changes brought about by enzymes and hydrolytic agents acting on proteid outside of the tissues. Thus in the germinating seed Schultze[3] finds that asparagin, leucin, tyrosin, histidin, arginin and lysin arise from the metabolism of proteid. The occurrence of leucin and tyrosin in the liver and urine in such diseased conditions as phosphorus poisoning has long been known and Abderhalden and Bergell[4] report the presence of glycocoll in rabbit's urine after the administration of phosphorus. Urine after phosphorus poisoning may also contain phenylalanin[5] and arginin.[6] Wakeman[7] finds an altered quan-

[2] Abderhalden, E., *Zeitschr. f. physiol. Chem.*, 1905, Bd. 44, p. 17.

[3] Schultze and Castero, *Zeitschrift für physiologische Chem.*, 1904, Bd. 44, p. 455.

[4] Abderhalden and Bergell, *Zeitschrift für physiologische Chem.*, 1903, Bd. 39, p. 464.

[5] Abderhalden and L. F. Barker, *Zeitschrift für physiologische Chem.*, 1904, Bd. 42, p. 524.

[6] Wohlgemuth, *Zeitschrift für physiologische Chem.*, 1905, Bd. 44, p. 74.

[7] Kossel, *Berliner klinische Wochenschrift*, 1904. No. 41.

titative relationship between histidin, arginin and lysin in the composition of liver substance after phosphorus poisoning, arginin in particular being reduced below the quantity found in the liver of the normal dog. This possibly suggests a specific action by phosphorus on certain cell proteids rich in arginin which are essential to vitality. All forms of proteid decomposition follow, therefore, the pathway of cleavage into amino acids.

The question arises, to what extent may the amino bodies formed within the intestine be regenerated into proteid? It is believed that the cells of the intestinal villus regenerate fat from fatty acid and glycerin, since neutral fat alone is found in the thoracic duct. But all the starch fed is not regenerated into starch, nor is maltose regenerated into maltose in the body. Much may be burned as dextrose and only a part is transformed into glycogen. Long ago Schultzen and Nencki[8] stated that a certain amount of amino bodies formed in digestive proteolysis was absorbed and burned, and that the absorbed proteid itself followed the lines of an enzymatic cleavage into amino bodies. In the light of newer knowledge several authorities have recently elaborated theories along similar lines. It has been pointed out by Folin[9] that there is little evidence of reconstruction of all the proteid ingested. He cites the experiments of Nencki and Zaleski,[10] which showed that the portal blood during digestion contains four times as much ammonia as arterial blood, and that the mucosa of both stomach and intestine yield large quantities of ammonia. The inference is that the ammonia of the portal vein is derived from ammonia produced in the mucosa as well as from that which normally originates in the intestine during tryptic proteolysis.

The existence of denitrogenizing enzymes is afforded by the example of the guanase and adenase of Walter Jones,[11] which respectively convert guanin into xanthin and adenin into hypoxanthin with the liberation of ammonia.

Folin believes that the greater part of the proteid ingested undergoes a denitrogenization through the hydrolysis of the amino cleavage products. Such a reaction would read

$$= CNH_2 + H_2O = \quad COH + NH_3.$$

The ammonia may be converted into urea within the organism, and the nitrogen free rest may be converted into sugar. The simplest expression of this is seen in the experiment of Neuberg and Langstein,[12] who found glycogen in the liver and lactic acid in the urine of a rabbit following the ingestion of alanin. The transformation of alanin into lactic acid may be written

$$\underset{\text{Alanin.}}{CH_3 \cdot CHNH_2 \cdot COOH} + H_2O = \underset{\text{Lactic Acid.}}{CH_3 \cdot CHOH \cdot COOH} + NH_3.$$

The transformation of lactic acid into sugar is demonstrated by the experiment of A. R. Mandel,[13] who showed an increase in the sugar output in diabetes after the ingestion of lactic acid.

Stiles and Lusk[14] have shown that ingestion of the mixture of amino bodies produced from the tryptic digestion of meat may yield sugar in large quantity in diabetes.

[8] Schultzen and Nencki, *Zeitschrift für Biologie*, 1872, Bd. 8, p. 124.

[9] Folin, *American Journal of Physiology*, 1905, Vol. 13, p. 117.

[10] Nencki and Zaleski, *Zeitschrift für physiologische Chem.*, 1901, Bd. 33, p. 206.

[11] Jones and Winternitz, *Zeitschrift für physiologische Chemie*, 1905, Bd. 44, p. 1.

[12] Neuberg and Langstein, *Archiv für Physiologie*, Suppl. Bd., 1903, p. 514.

[13] Mandel, 'Proceedings of the American Physiological Society,' *Am. Jour. of Physiol.*, 1905, Vol. 13, p. xvi.

[14] Stiles and Lusk, *American Journal of Physiology*, 1903, Vol. 9, p. 380.

Wolf[15] finds that none of these amino substances has any effect on the blood pressure of animals, so far as he has examined them.

Although some proteid metabolism may take place as above outlined, it is an undoubted fact that proteid may be synthesized in the body with the formation of new tissue, and also that proteids injected into the blood stream, as in cases of transfusion of blood serum, are rapidly destroyed and the nitrogen eliminated as urea. The conditions of proteid metabolism may, therefore, be entirely similar to those of starch metabolism, (1) digestive hydrolysis, (2) partial combustion of the end products, and (3) possible regeneration of portions of the end products into substances similar to the originals, but characteristic of the organism, *i. e.*, glycogen and body proteids. In the case of proteids the second or metabolic process involves the partial passage of the end products through the glucose stage. The third or regenerative process is promoted by such a proteid as casein, which yields a variety of cleavage products.

Folin[16] has discovered that a man fed with creatin free food eliminates a constant quantity of creatinin nitrogen in the urine irrespective of the amount of nitrogen ingested with the food. Thus the urine of one man contained 16.8 grams of total nitrogen with 0.58 gram of creatinin nitrogen. The same man at another time, after large carbohydrate ingestion, eliminated 3.60 grams of total nitrogen and 0.60 gram of creatinin nitrogen. Folin conceives that the constancy of the creatinin and uric acid output is a true index to the necessary protoplasmic breakdown, and would define the nitrogen of such destruction as the endogenous nitrogen. To what extent, if any, urea nitrogen enters into this essential life metabolism he is not prepared to say. The same idea was expressed by Burian[17] in an article published ten days later than Folin's. Burian believes that purin bases are a constant product of muscle metabolism and that these are oxidized to uric acid, a part of which is further converted into urea. This process of itself would evolve urea as a constant product of the endogenous nitrogen metabolism. According to this newer conception the cells of the body through the swinging motion of their particles do continually break down their own protoplasm with the production of creatinin, purin bases, and perhaps other substances. These same cells may also break up exogenous amino radicles derived from ingested proteid or circulating proteid itself.

Neuberg and Loewi[18] have made an observation which is not in accord with the idea that proteid metabolism normally passes through the amino-acid stage. These authors investigated a case of cystinuria, a condition in which cystin formed from proteid can not be burned, but is eliminated in the urine. After ingesting leucin, tyrosin and aspartic acid these also were almost quantitatively eliminated in the patient's urine, although the normal organism burns them. Since these substances were not eliminated by the patient on a normal diet, the presumption is that they can not be normal products of intermediary proteid metabolism. The authors find it difficult to explain this according to the conception of a general breakdown of proteid into amino acids. This experiment lacks confirmation.

[15] Wolf, *Journal of Physiology*, 1905, Vol. 32, p. 171.

[16] Folin, *American Journal of Physiology*, 1905, Vol. 13, p. 66.

[17] Burian, *Zeitschrift für physiologische Chem.*, 1905, Bd. 43, p. 532.

[18] Neuberg and Loewi, *Zeitschrift für physiologische Chemie*, 1904, Bd. 43, p. 338.

As regards fat metabolism Geelmuyden[19] is inclined to the opinion that oxybutyric acid, aceto-acetic acid and acetone are normal metabolism products derived from members higher up in the series.

As regards dextrose Stoklasa[20] announces that all animal and vegetable cells contain enzymes capable of converting dextrose into alcohol and carbon dioxide. He[21] also finds a ferment in animal tissues able to convert sugar into lactic acid. He quotes Oppenheimer's experiment, showing that whereas fresh normal blood yielded little lactic acid on standing at 37° C., much greater amounts were formed if dextrose was added. He believes that this lactic acid is subsequently converted into alcohol and carbon dioxide.

Embden[22] comes to the conclusion that blood sugar perfused through the liver may be broken up into lactic acid. It has been previously shown that lactic acid could be converted into dextrose and it is a curious fact that this same dextrose may pass through the lactic-acid stage on its way to oxidation.

A. R. Mandel[23] in the writer's laboratory has shown that lactic acid disappears from the blood and urine in phosphorus poisoning if diabetes be induced. Here the mother substance of the accumulating lactic acid is removed in the urine. Any considerable production of alcohol in tissue metabolism, while possible, does not seem probable in light of the known physiological action of the substance.

[19] Geelmuyden, *Zeitschrift für physiologische Chem.*, 1904, Bd. 41, p. 128.

[20] Stoklasa, *Centralblatt für Physiologie*, 1903, Bd. 17, p. 465.

[21] Stoklasa, Jelinck und Cerny, *Centralblatt für Physiologie*, 1903, Bd. 16, p. 712.

[22] Embden, 'Verhandlungen der 6sten Internationalen physiologen Congress,' *Centralblatt für Physiologie*, 1905, Bd. 18, p. 832.

[23] Mandel, 'Proceedings of the Am. Physiol. Society,' *American Journal of Physiology*, 1905, Vol. 13, p. xvi.

Rubner[24] gives the following theory of metabolism: Living proteid, through the vibrations of its particles, metabolizes the food substances. The action resembles catalysis. The energy liberated reacts on the particles of protoplasm, causing a change in their position and a cessation of metabolism. The particles then return to their original position and the cycle begins again. These processes require a fixed amount of energy. Rubner does not give his reasons for believing in this rhythm of excitation and rest.

The quantity of the combustion depends on the power of the cells to metabolize (Voit). In the resting state this metabolic power of the cells is influenced by the 'law of skin area' (Rubner). Temperature (cooling or warming) and nerve excitation (muscle work, chemical regulation) affect the power of the cells to metabolize, perhaps through an increase in the oscillation of the particles, an effect which is in turn maintained at the expense of the energy derived from metabolism. Living protoplasm metabolizes in accord with its necessities at the time, and never more. Large quantities of nutrient materials furnished will not increase cell metabolism. If food be ingested above the requirement for the organism, any excess will be retained in the body. The kind of metabolism depends upon the constitution of the fluid feeding the cells, and whether proteid, carbohydrates or fats have been ingested.

Each ingested foodstuff exerts a specific dynamic action (Rubner). At a temperature of 33° C. the ingestion of the starvation requirement of energy in the form of fat increases the requirement for energy ten per cent., carbohydrates raises it five per cent., proteids thirty per cent. In other words, in the case of meat, in order to obtain calorific equilibrium about 140 calories

[24] Rubner, 'Von Leyden's Handbuch der Ernährungstherapic,' 1903, p. 78.

must be ingested instead of 100, if that represents the starvation requirement. Rubner[25] explains that the cells of the body do not require more energy after meat ingestion than in starvation, but that the heat produced by a preliminary cleavage of proteid into dextrose on the one hand, and into a nitrogen containing rest on the other, while yielding heat to the body does not furnish the actual energy for the vital activities of the protoplasm. This is furnished principally by the dextrose derived from the proteid. Although it is necessary to abandon the older theory which pronounces glycogen (or dextrose) a direct cleavage product of proteid, still the explanation of Rubner remains tenable if interpreted in the newer light. If the energy requirement of the cell remains constant at 100, even after the ingestion of 140 calories of proteid, then 71.4 per cent. of the total heat value of the proteid is the quantity actually used for the vital processes. Since it has been shown in the writer's laboratory that meat proteid yields 58 per cent. of dextrose in metabolism, it may be calculated that 52.5 per cent. of the total energy of proteid may be available for the cells in the form of sugar. A balance of 19 per cent. must be obtained from other compounds, while 28.5 per cent. of the total heat value is wasted as heat without ever having been brought into the service of the life processes of the cells. Perhaps this 28.5 per cent. of heat loss represents the quantity produced by the cleavage of proteid into amino bodies and the denitrogenization of these radicles.

The constancy of the energy requirement in metabolism makes difficult the explanation of the action of the various ferments found in the body. These are of two varieties, hydrolytic and oxidizing, but these from the very principles of our knowledge must be subservient to th quirement of the living cells, and not t selves masters of the situation, as, fo ample, they are in the autolysis of tissue. It seems to be the requireme the mechanism of cell activity which termines metabolism, and not primaril action of enzymes, whose influence app to be only intermediary.

Friedenthal[26] shows that proteid, loidal carbohydrates, fats and soaps not oxidizable in the cellular fluids wit previous hydrolytic cleavage. After drolysis, however, the oxidases may e an oxidation of the smaller molecules. necessity of the hydrolytic ferment is in the non-combustion of dextrose after extirpation of the pancreas, the organ which the ferment is supplied. Oxy and the oxidases are present in ample qu tity, but the sugar is not burned unles be broken by its specific ferment. In meantime the cell avails itself of a comp satory energy supply from other sour It is impossible to apply anything simi to Ehrlich's side-chain theory to this c dition of affairs, for the metabolism d not depend upon the satisfaction of ch ical affinities, but rather upon a defi law of utilization of energy equivalents

However clearly formulated the laws metabolism may be, and many of them as fixed and definite as are any laws physics and chemistry, still the prim cause of metabolism remains a hidden cret of the living bioplasm.

GRAHAM LUSK

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[25] Rubner, 'Gesetze des Energieverbrauchs,' 1902, p. 380.

[26] Friedenthal, 'Verhandlungen der Berli Physiologischen Gesellschaft,' *Archiv für Phys ogie*, 1904, p. 371.

SCIENTIFIC BOOKS.

Notes on Anthropoid Apes. By the H WALTER ROTHSCHILD.

This paper, in the last number of the *P ceedings of the Zoological Society of Lond*

(1904, Vol. II., Pt. II., 413–440), is based in the main upon recent studies by Professor Matschie, published in the *Sitz. Ges. Naturf. Freunde.*

A review of the systematic portion of Mr. Rothschild's paper could not be profitably undertaken at present, at least by an American zoologist, for lack of material by which values could be estimated, and still more by reason of the absence from his paper of almost all details in support of its conclusions except a few of dubious significance. The doubt may be expressed, however, whether even the German naturalist, though his material has much exceeded that ever before brought together, has had anything like a sufficient amount to establish the nature and the taxonomic value of many of his characters. One point which may be briefly noticed is Matschie's proposal, adopted by Rothschild (p. 413), that the gibbons should form a family, Hylobatidæ, quite apart from the other anthropoids. It appears to me that nothing could be further from sound principles of classification. By reason of their somewhat intermediate anatomical structure, the gibbons might, perhaps, be used to break down the separation of anthropoids and old-world monkeys into two families, but they are far too closely allied to the first in all distinctive characters, to be added as a third group in the series.

Reference may also be made here to the biological improbability of four subspecies of orang, each presenting the same dimorphic forms (p. 434).

The changes in nomenclature, proposed chiefly by Matschie, are so serious in their results that they need examination. It is proposed to transfer the generic name *Simia* Linn. from its time-worn association with the orang to the chimpanzees, and to apply to the former the name *Pongo* Lacép. Now a complete reversal in the relation of a generic and specific name a century and a half old, with the upsetting of all depending nomenclature, should be shown to be unavoidable before it is proposed. Is it so here? The contention is that it results from taking the tenth edition of the 'Systema Naturæ' (1758) as the starting point, instead of the twelfth edition (1766), for the reason that *Simia satyrus* of the tenth was based on the *Satyrus indicus* of Tulpe (1641), which Mr. Rothschild holds to be so unmistakably a chimpanzee that 'we can even distinguish the exact race to which it belongs.'

The whole question, therefore, hangs on the certainty with which this animal can be identified. To me it appears doubtful, as it did to Hartmann, what animal Tulpe really meant. He calls it *Satyrus indicus* and gives the habitat as 'Africa, Asia.' The '*crinibus nigris*' of his description is the one character to distinguish it from the red orang, but it does not serve to distinguish one species of chimpanzee from another, or more than doubtfully from a young gorilla. Turning to Tulpe's figure the zoologist of experience with living anthropoids is likely to recognize much more resemblance to the orang than to the chimpanzee in the head, the small ear, the protuberant paunch, the size of the great toe and in the whole attitude of the animal.

Linnæus had really never seen any of these apes and his names are based on statements of other authors who were not able to differentiate the red ones of the Oriental region from the black ones of the Ethiopian, and his genus *Simia* of the tenth edition does not rest surely —to quote the American code—upon 'a designated recognizable species * * * or plate or figure.' In the twelfth edition his *Simia satyrus* is, without question, the orang, the chief reference being to Edwards's plate 213 (1758), which being colored leaves no doubt as to which animal is figured. The fact is that *Simia* Linn. is merely a composite of all the monkeys known to that author, and has with others of his genera been imposed upon literature more by reverence for his name than through any exact application borne by them. This being true in many cases, and *Simia satyrus* of the tenth edition not being certainly identifiable, rather than overturn the whole nomenclature of two genera, or even worse to reverse it, it seems quite within legitimate practice to regard it as a *nomen nudum* as far as the tenth edition is concerned, and let it take date from its first unquestioned use in the twelfth.

An unfortunate result of the contrary view held by the two authors is that *Pongo* Lacép. (1799) takes the place of *Simia* for the orang. Unfortunate, for however much the proper use of this word has been confused by later authors, old Andrew Battell, in 'Purchas' made it clear that the native name *pongo* belongs to the gorilla, and while it is true that some of the codes now in use do not consider that grievous misapplication in meaning is cause for removal, it may be doubted if any rule which serves to perpetuate error in fact stands on a lasting base where scientific exactness is the object.

Simia satyrus being transferred to a species of chimpanzee, the proper name for the orang, according to Mr. Rothschild (p. 421), is *Pongo pygmæus* (Linn.). The paper of Linnæus's understudy, Hoppius, in the 'Amœnitates Academicæ' (1763), which is the reliance for this, is not really binominal and should not be considered. The first available use of *pygmæus* is in Schreber (1796), where it is based on Tyson's excellent figure of a chimpanzee. This is adopted by Rothschild for one of the chimpanzees, as *Simia pygmæa* (Schr.); the orang being *Pongo pygmæus* (Linn.)—an ill-judged and indefensible confusion.

All these lamentable changes may be avoided by the manner of treatment I have suggested, which appears to me to be quite within the rules. Present synonymy will be undisturbed and an appalling amount of confusion will be escaped. How great this is will be seen on attempting to correlate Mr. Rothchild's nomenclature with some known species. The only change required is that *Pan* Oken (1816) seems necessary for the chimpanzee, but this does not entail any alteration in specific names.

If it is to be regretted that Mr. Rothschild (p. 421) has followed Matschie so closely as to continue the erroneous date of '*Satyrus* Lesson, 1799'—which should be 1840—it is, at least, unalloyed gratification to be assured (p. 440) that the distinguished author and patron of zoological science is prepared to lead continental and American zoologists in the ‹ paign for a system of pure trinomials.

ARTHUR ERWIN BROW

ZOOLOGICAL GARDENS, PHILADELPHIA,
May 27, 1905.

SCIENTIFIC JOURNALS AND ARTICL

The American Naturalist for June cont the following articles:

E. W. BERRY: 'Fossil Grasses and Sedges.

H. W. RAND and J. L. ULRICH: 'Posterior nections of the Lateral Vein of the Skate.'

H. W. RAND: 'The Skate as a Subject Classes in Comparative Anatomy; Injec Methods.'

T. H. ROMEISER: 'A Case of Abnormal Ve System in *Necturus maculatus*.'

R. H. HOWE, JR.: 'Sir Charles Blagden, earl of Rhode Island Ornithologists.'

C. R. EASTMAN: 'The Literature of Edestus

SOCIETIES AND ACADEMIES.

THE BOTANICAL SOCIETY OF WASHINGTON.

THE twenty-ninth regular meeting of Botanical Society of Washington was held the Portner Hotel, May 27, 1905. The f lowing papers were presented:

Evolutionary Status of the Laminariace: WALTER T. SWINGLE.

Mr. Swingle's paper was illustrated specimens from the algal herbarium of M W. T. Swingle. It was pointed out that the twenty-two genera belonging to the tr Laminariaceæ (*Corda* and *Adenocystis* bei excluded) twelve (or over one half) are li ited to the Pacific coast of the United Stat from Lower California to British Columb In all, sixteen genera occur within these limi while two more occur in Alaska and one mo in New England, making nineteen genera all from the United States territory in Nor America, or *over four fifths of the know genera*. In this territory there are fifty-o species, or almost exactly half of the one hu dred and five species now known from th whole world.

The Laminariaceæ were shown to be col water algæ and are limited in their distrib tion chiefly by the summer temperatures the sea water. The family originated in th

northern Pacific Ocean, or at least here was where their greatest evolutionary progress occurred. Sixty-four species occur here and fifty-five are found nowhere else. All the twenty-two genera occur in the northern Pacific. In the southern hemisphere, where the temperature conditions are favorable to the growth of these algæ, as is shown by the prodigious size attained there by *Macrocystis*, and by its extreme abundance, only three genera occur containing but fourteen species, all but two restricted to the southern hemisphere. These species are probably descendants of forms that crossed the equator during the glacial period when the ocean had a much lower temperature in the tropical zone. That period has occurred in the southern hemisphere; at least it is shown by the failure of *Macrocystis* to cross into the northern Atlantic Ocean, where it would find a larger region admirably adapted for its growth.

These algæ attain the greatest length of any plant, *Macrocystis* reaching a length of 400 to 700 feet or over. Some of the forms, such as *Palagophycus* and *Nereocystis*, are annuals and must grow much faster than any other organisms in order to attain in the course of a few months their enormous length (100 to 200 feet or over).

The large size and high differentiation of tissues attained in this group, and especially the occurrence of well-marked species and very distinct genera, render it highly probable that sexuality occurs in spite of the prevailing opinion of algologists to the contrary.

The Flora of a Sphagnum Bog: C. E. WATERS.

An account was given of a sphagnum bog in Ann Arundel County, Maryland. The characteristic plants of the bog proper, of the low wet woods along the stream flowing through it, and of the surrounding dry woods, were shown to be of unusual botanical interest. In the dry woods *Quercus prinoides*, *Q. nana* and *Castanea pumila*, together with *Kalmia angustifolia*, *Vaccinia* and other heaths, are abundant. *Iris verna*, *Chrosperma muscœtoxicum*, *Gaultheria*, *Rhus toxicodendron* and *R. radicans*, etc., are common. In the more open parts of the bog are found *Sarracenia purpurea*, *Drosera rotundifolia*, *D. intermedia*, *Eriocaulon decangulare*, *Utricularia* sp., *Castalia odorata* (in three or four inches of water), *Lycopodium adpressum* and *Blephariglottis cristata* have been found. Just below the bog is a shallow pond in which occur *Brasenia peltata*, *Potamogeton* sp., *Nymphœa advena*, *Castalia odorata*, and a rapidly increasing colony of *Marsilea quadrifolia* introduced six or eight years ago. Around its margin *Blethia* and several heaths are found. No *Isoetes* has ever been discovered, in spite of apparently ideal conditions. In the wet woods are very large colonies of *Woodwardia areolata*, *Nephrodium simulatum* and *Osmunda cinnamonea*, together with the form *glandulosa*, for which this is the type locality. *N. cristatum*, *N. boothi* and *N. spinulosum*, *Woodwardia virginica*, *Smilax walteri*, *Magnolia virginiana*, *Blephariglottis blephariglottis*, *Perularia flava*, and many other plants are found. In the rather swift stream with gravelly bottom *Vallisneria spiralis* is plentiful. Practically none of the common spring flowers usually found in low rich woods are known to occur there. Many other common plants are also missing, one of the most notable being *Equisetum arvense*, which is abundant along railroads, etc., in Baltimore County, but has not been seen in the region under discussion. The absence of *Typha* in the bog was especially noted, and in the discussion which followed the paper the fact was brought out that it is rarely if ever found growing with *Sphagnum*.

THE twenty-eighth regular meeting of the Botanical Society of Washington was held at the Portner Hotel, April 29, 1905. The following papers were presented:

Recent Results with the Use of Copper in City Water Supplies: KARL S. KELLERMAN.

The use of copper for eradicating algal pollution is now generally recognized as the most practical successful method of dealing with this troublesome phase of water engineering.

Copper has been proposed, also, as an agent for disinfecting water supplies contaminated with pathogenic bacteria, and considerable discussion has been aroused as to the advisability

of this application of the copper method, except in cases of extreme necessity. There are two ways of using copper as a water supply disinfectant. One plan is to treat the supply directly, in the reservoir if there be one, or at the intake gallery if the water be drawn from a lake or stream. In the latter case the treatment necessarily must be continuous. The second plan is to treat water before filtration. By the use of suitable chemicals, all the copper is precipitated and removed from the water by the subsequent filtration.

Albuquerque, N. M., and Columbus, O., are examples of the first plan of treatment. These two cities greatly reduced the number of typhoid cases during epidemic seasons, and the chemical examinations that were made failed to show copper in the water drawn from faucets of consumers.

Anderson, Ind., is an example of the second plan of treatment, and even with the filters laboring under structural defects[1] it seemed possible to remove all bacteria usually supposed to indicate sewage contamination.

Disease Resistance in Plants: W. A. ORTON.

The Occurrence of Extractives in Apple Skin: HERBERT C. GORE.

HERBERT J. WEBBER,
Secretary.

[1] I am informed that these defects are now remedied.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 603d regular meeting was held May 27, 1905. The evening was devoted to papers on absolute electrical measurements with a description of the experiments now in progress at the Bureau of Standards.

Dr. K. E. Guthe spoke on the 'Methods and Apparatus Employed in the Absolute Measurement of Electric Current.' After a short introduction regarding the purpose of absolute electrical measurements, the speaker described and discussed the different methods and apparatus which have been employed for the absolute measurement of an electric current and —by the use of a known resistance—of the electromotive force of standard cells. The tangent galvanometer and similar methods are based upon the knowledge of the horizontal component of the earth's magnetic field and this can hardly be determined more accurately than to 1 in 2,000, except by the most refined methods. The different forms of current balance make use of the absolute value of gravity. In the electrodynamometer methods the preliminary measurements include the determination of the elastic properties of the suspension. The electrodynamometer which is being constructed at the Bureau of Standards was described more fully. Finally the results obtained for the electrochemical equivalent of silver were compared and the need for new determinations with reliable coulometers pointed out.

Professor E. B. Rosa presented 'The Methods and Apparatus Employed in the Determination of v, the Ratio of the Electromagnetic to the Electrostatic Unit of Electrical Measurement.' After a discussion of the older work the apparatus now in use by the speaker and Dr. Dorsey was described. A rapidly charged and discharged spherical condenser is inserted in one arm of a Wheatstone bridge and the galvanometer deflection brought to zero; the quantity which is regulated by hand is the number of charges per second. The resulting value of v seems to lie between 2.9964 and 2.9968×10^{10} cm.-sec. —a range of 1/5000.

In the discussion that followed Dr. Bauer put the precision of the determination of H, the earth's horizontal magnetic force, at 1/4000; an instrument may be sensitive to 1/20000, yet differ from another by 1/500; and Mr. Wead spoke of the disregard of the masterly research of Cornu on the velocity of light, in comparison with the results under less widely varied conditions of the brilliant American experiments.

CHARLES K. WEAD,
Secretary.

THE NEW YORK ACADEMY OF SCIENCES. SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

THE regular monthly meeting of the section was held at the American Museum of Natural History, on Monday evening, May 15. The papers presented were as follows:

Relation between Ionization and Combustion in Flames: F. L. Tufts.

This paper was a preliminary communication concerning work that is still in progress. The method employed in determining the electrical conductivity of a flame has been described in a previous paper (*Physikalische Zeitschrift,* 5 Jahrgang, No. 3, pp. 76–80), and some results of applying it to a study of combustion have been given in an extract published in the *Physical Review* (Vol. XX., No. 3, p. 186). The present paper gave the results of investigations carried on for the purpose of determining the influence, on the electrical conductivity of a gas flame, of mixing CO_2 or air with the illuminating gas before supplying it to the burner.

The results showed that for small flames, showing little carbon luminosity, the admixture of either CO_2 or air caused no marked increase in the electrical conductivity, the amount of gas consumed per second being kept constant. For very small flames the admixture of either caused a decrease in the conductivity. For large flames, however, the admixture of either CO_2 or air caused an increase in the conductivity, which continued until enough CO_2 or air had been added to destroy the carbon luminosity, when the conductivity was as much as twenty-five per cent. larger than for a flame consuming the same quantity of undiluted gas. Continuing the addition of CO_2 beyond this point caused a decrease in the conductivity until the flame was extinguished. Continuing the addition of air caused at first a slight decrease, until the inner blue cone became well developed, when the further addition of air caused an increase in the conductivity, the conductivity reaching a larger value than it had on the disappearance of the carbon luminosity.

The Rate of Recombination of the Ions in Air: L. L. Hendren.

The experiments described were undertaken to determine by a somewhat new method the absolute value of the coefficient of recombination of ions in air and more especially its variation with the pressure. The ionizing agent was a very active solution of radium chloride spread over the surfaces of two large parallel metal plates. By this means a very large ionization was obtained compared with that obtained by previous observers using the Röntgen rays. The results showed that as the pressure decreases the coefficient of recombination decreases with an increasing rate from a value of 5,500 at atmospheric pressure to 1,000 at 10 mm. pressure.

Radiation Pressure and Differential Tones: G. B. Pegram.

It was pointed out that the differential tones heard on sounding loudly two tones of different pitch may be considered as arising from the radiation pressure of the sound waves acting on the ear-drum. While the question of radiation pressure, or the pressure on any surface that is reflecting or absorbing energy coming up to it, has not admitted of a general treatment, such a pressure, proportional to the energy per unit volume of the medium transmitting the energy has been shown theoretically to exist in many cases, and proven experimentally in some. In the case of sound waves the theoretical treatment of the pressure on a reflecting surface is not at present satisfactory (see Poynting, *Phil. Mag.,* April, 1905), but experimentally it has been measured by Altberg and shown by Wood in a striking manner by an experiment described in the *Physical Review.*

Now if two tones of different pitch are sounded together, beats ensue, so the amount of energy coming up to the ear varies periodically with the rise and fall in loudness of the resultant sound. But when the most energy is coming up to the ear, or when the sound is loudest, the radiation pressure on the ear-drum is greatest; when the energy coming up to the ear is least, or when the sound is faintest, the radiation pressure is least. The effect of this variation of pressure on the ear-drum will be to set it into vibration with a period equal to that of the beats, and so, if the beats are of proper frequency, cause the sensation of a tone of that frequency, that is, the differential tone of Helmholtz.

While this explanation of differential tones from the standpoint of radiation pressure has,

perhaps, the same mechanical basis as Helmholtz's explanation, it seems not amiss to approach it in this way. An attempt is being made at a mathematical treatment.

C. C. Trowbridge,
Secretary.

DISCUSSION AND CORRESPONDENCE.

HIGHER AND LOWER.

To the Editor of Science: In the *American Naturalist* for June, on page 413, L. J. C. takes exception to the custom of referring to animals as 'higher' and 'lower,' on the ground that these terms tend to give the student an idea that the vertebrate affinities lie in a direct chain, rather than forming a complicated, branching system.

This criticism will strike some as a little captious since the terms do not imply a direct connection, but merely that some animals are on a higher plane than others, just as the dwellers on the fifth floor of an apartment house are higher than those on the fourth floor. The terms generalized and specialized fail to convey the idea intended because a highly specialized animal may be low in the scale of life. The sloth is more specialized than the monkey, but it would naturally be termed a lower animal; thus though what we call the 'higher' animals are, as a rule, more specialized than the 'lower' forms, they are by no means invariably so. To revert to the apartment house it may be said that a family on the fifth floor might be related to one on the fourth and another on the sixth and yet, as a whole, the fifth floor people would be higher than those below.

F. A. L.

A DENIAL.

To the Editor of Science: In a circular sent out by The Macmillan Company advertising one of their recent publications, the assertion is gratuitously made that I 'uphold Wallace's position.' Kindly allow me the space to deny the statement and to explain that it arose first from a misapprehension, which was later compounded by a clerical error—not mine.

Hubert Lyman Clark.

SPECIAL ARTICLES.

THE FISHES OF PANAMA.

In the Zoological Club of Indiana University in 1885 or 1886 President D. S. Jordan gave a résumé of the facts known at that time concerning the relation of the marine faunas on the two sides of Panama. It was jokingly remarked at that time that at the rate of progress the canal might be finished by 1900 and that zoologists would have to bestir themselves to record the faunas as they exist before the Panama canal would mix things up. It is now 1905 and the canal is not finished. In the meantime the marine faunas have been dealt with by

1. Gregory, L. W.: 'Contributions to the Palæontology and Physical Geology of the West Indies,' *Quart. Journ. Geol. Soc.*, Vol. 4, 1895, pp. 255–312.

2. Faxon, Walter: 'The Stalk-eyed Crustacea,' *Mem. Mus. Comp. Zool.*, Harvard College, Vol. XVIII., 1895, pp. 1–292.

3. Gilbert, C. H., and Starks, Edwin C.: 'The Fishes of Panama Bay,' *Mem. Cal. Acad. Sci.*, Vol. IV., pp. 1–226.

Gilbert and Stark's conclusions are that:

"The ichthyological evidence is overwhelmingly in favor of the existence of a former open communication between the two oceans, which must have been closed at a period sufficiently remote from the present to have permitted the specific differentiation of a very large majority of the forms involved." They found that 'of the 82 families of fishes represented at Panama all but 3 (Cerdalidæ, Cirhitidæ and Nematestiidæ) occur also on the Atlantic side of Central America; while of the 218 genera of our Panama list, no fewer than 170, are common to both oceans.' Fifty-four out of a total of 374, or 144 per cent., of the Pacific coast species are identical with Atlantic coast species.

I have just finished a consideration of the geographical distribution of the freshwater fishes of tropical America and Patagonia as applied to the Archihelenis-Archiplata theory of von Ihering. The details will appear in one of the volumes of the Hatcher reports of Princeton University. The evidence there collected indicates that the Pacific slope fauna

of tropical America has been derived from the Atlantic slope fauna. Only three of the genera of fresh-water fishes of the Pacific slope are peculiar to it; all the rest are identical with Atlantic slope genera. Even many species are identical on the two sides. The indications are that in the main the Pacific slope fauna was derived from the Atlantic slope fauna in times much more recent than the obliteration of the interoceanic connection between the Pacific and Atlantic. An examination of the distribution of the genera with representatives on the Pacific slope on the Atlantic side of the continent shows that nearly all have a very wide range and are found either in the Rio Magdalena or the Chagres. This indicates that the present fresh-water fauna of the Pacific slope crossed the divide somewhere near Panama. It is to be borne in mind that a barrier which may be ample to keep apart two marine faunas is not necessarily a barrier to the intermingling of two fresh-water faunas. It is quite within the range of possibilities that the Atlantic slope fauna ascended the Chagres and succeeded in crossing the low divide and descended the Pacific rivers. The Chagres route has a rival farther south. In Colombia the Cordilleras form four separate chains. The eastern, east of the Rio Magdalena, the central, between the Magdalena and its tributary, the Cauca, the western, west of the Cauca, and finally, a coast range. Between the western Cordillera and the coast Cordillera is a trough whose highest point is but 300 feet above sea level.

	Pacific Slope.	Atlantic Slope.
Rhamdia cinerascens Günther	Western Ecuador.	Chagres.
Rhamdia wagneri Günther	Bayano.	Chagres.
Pimelodus clarias (Bloch)	Bayano.	Chagres.
Pimelodella modestus (Günther)	Esmeraldas.	Chagres.
Pimelodella chagresi (Steind.)		Chagres.
Pimelodella gracilis (Val.)		Chagres.
Ancistrus chagresi (Eigenmann & Eigenmann)		Chagres.
Hemiancistrus aspidolepis Günther	Bayano.	
Chætostomus fischeri Steind	Bayano.	
Loricaria variegata Steind	Bayano.	
Loricaria uracantha Kner & Steindachner	Bayano.	Chagres.
Loricaria lima Kner	Bayano.	Chagres.
Sturisoma panamensis Eigenm. & Eigenm	Bayano.	Magdalena.
Hoplias malabaricus Bloch	Bayano.	Chagres.
Hoplias microlepis Günther	Western Ecuador.	Chagres.
Curimatus magdalenæ Steind	Mamoni.	Magdalena.
Brycon striatulus (Kner)	Pacific slope of Panama.	Chagres.
Astyanax panamensis Günther	Bayano.	Motagua.
Astyanax rutilus Jenyns	Western Ecuador.	Chagres.
Astyanax æneus Günther		Chagres.
Rœboides guatemalensis Günther	Huamuchol.	Chagres.
Gasteropelecus maculatus Steind	Bayano.	
Luciocharax insculptus Steind	Bayano.	Magdalena.
Eigenmannia humboldti (Steind)	Mamoni.	Entire east slope.
Pœcilia gillii Kner & Steind		Chagres.
Pœcilea punctatus Kner & Steind		Chagres.
Symbranchus marmoratus Bloch		Entire east slope.
Geophagus jurupari Heckel		Chagres.
Cichlasoma parma (Günther)		Chagres.
Cichlasoma godmanni (Günther)	Bayano.	

In the west Cordilleras to the east of this trough arise two rivers, both of which flow into the longitudinal valley, where one, the Atrato, flows to the north into the Caribbean,

the other, the San Juan to the south, and then through a break in the coast Cordilleras to the west to the Pacific Ocean. The height of land separating the two systems scarcely reaches a height of 100 m. This waterway is one of the strategic points in the geographical distribution of South American fishes and it is more than to be regretted that there is not a single record of a fresh-water fish from either of these rivers!

We are a little more fortunate about our knowledge of the fishes of the two sides of Panama, but are far from an exhaustive knowledge on the subject.

It would certainly be a disgrace not to make an exhaustive study of the fresh-water faunas of the two slopes before there is a chance of the artificial mingling of the two faunas. It ought to be urged upon congress to make provision for the biological survey of the canal zone if the president or the bureau of fisheries does not already possess authority to provide for it. The work should be undertaken at once.

For the biological survey of the Atrato-San Juan route we must depend upon private enterprise, and it is to be hoped that the means for so interesting and profitable work will not be lacking when the volunteers for the work are so numerous and willing.

On the preceding page I give the fishes recorded from the Chagres on the Atlantic and the Bayano and its tributary, the Mamoni, on the Pacific side of Panama, together with the distribution on the Atlantic or Pacific slope of species found in one of the rivers, but not in the other. C. H. Eigenmann.

THE NUMBER OF YOUNG OF THE RED BAT.[1]

During the summer of 1904 four females of *Lasiurus borealis* with their young came under my observation, the data from which add to the information contained in a recent article on the subject by M. W. Lyon, Jr., in *Proc. U. S. National Museum,* Vol. 26, pp. 425–426, recording the capture of a female of this species with four nursing young, at Washington, D. C., June 18, 1902.

The Milwaukee specimens were all taken in the daytime clinging to the trunks of shade trees between the sidewalks and curbs in thickly populated residential parts of the city.

On July 14 a female with a single rather large young clinging to her was brought to me at the Public Museum. A few days later a female with three much smaller and less developed young was brought in after having been kept in captivity for a day or two until the mother had died. The young of this group were approximately the size of those figured by Mr. Lyon in the above-cited paper.

On July 23 a female with four larger young was brought to the museum. In this case the mother and young were alive. They had been confined for some hours in a pasteboard box and were quite restless. The half-grown young were clinging indiscriminately to each other and to the mother, who seemed fairly mobbed by her numerous progeny. A few days later I was shown another female with but a single young.

Of this bat Mr. Lyon cites observations of two having two young each, two having three and the instance under his own observation of one having four. Adding my own observations to this, we have the following records for number of cases and number of young: 2×1, 2×2, 3×3 and 2×4.

On the face of this tabulation it would appear that three is the more common number of young and that a single young is as frequent as four. However, it is not improbable that the females with single young may have lost others of their families either by death or by their accidentally becoming detached.

Two embryos were found in each of two females included in the above table and three embryos were found in two other included instances; consequently, it is certain that either two or three young may be born, but it does not appear equally certain that as small a number as one may occur at a birth, although that number appears to be common to genera other than *Lasiurus* and, as Mr. Lyon states, probably *Dasypterus*.

[1] Presented before the Wisconsin Natural History Society, March, 1905.

It is interesting to note, as pointed out by Mr. Lyon, that this unusually large number of young is coincident with the possession of four mammæ, whereas two is the number known in other bats.

That the mammæ of an animal should be as many as the normal number of young produced would appear to be a reasonable proposition, but that the normal number of young equals the number of mammæ is quite a different one, from which many exceptions will suggest themselves. For instance, the seals have four mammæ, yet one young is the rule and two the exception among the species with which I am familiar.

The fact of an increased number of mammæ in these bats correlates well with the observed fact of an unusual number of young, and I would be pleased to know of farther observations that may tend to establish what is the average number.

HENRY L. WARD.

PUBLIC MUSEUM, MILWAUKEE.

BOTANICAL NOTES.

PLANT CELL STUDIES.

UNDER the title of 'Studies on the Plant Cell' Dr. B. M. Davis is bringing together in a series of articles published in the *American Naturalist* (May, 1904, to April, 1905) what is known of the structure and activities of the plant cell. This is necessary because of the inadequacy and incompleteness of the accounts to be found in even the most recent botanical text-books. The author hopes, also, to 'help to change an attitude toward investigations on the plant cell that is unfortunately too prevalent among botanists,' *i. e.*, to regard cytology as a very special field with an elaborate technique beyond the capabilities of the average botanist. In carrying out this plan the author divides the subject into six sections, viz.: (I.) The structure of the plant cell; (II.) the activities of the plant cell; (III.) highly specialized plant cells and their peculiarities; (IV.) cell unions and nuclear fusions in plants; (V.) cell activities at critical periods of ontogeny in plants; (VI.) comparative morphology and physiology of the plant cell. The treatment under each of these heads, as far as published, is very satisfactory, and the author has certainly succeeded in making a most lucid statement in regard to every point. Where necessary he does not hesitate to indicate our lack of knowledge in regard to any structure, as when he discusses the nucleolus, and says that its substance is not well understood. Yet he does not refrain from stating his belief where it may be an aid to a clearer general understanding of the subject, as in the discussion of the pyrenoid, which he conjectures will prove to be a metabolic center of the chromatophore which is more or less prominent according to conditions of nutrition, whose most conspicuous activity is 'the formation of starch by the direct transformation of portions of its substance.'

In the discussion of direct-cell division the author suggests the possibility that this may be a reversion to early ancestral conditions, mitosis being regarded as phylogenetically a later process. With regard to centrospheres the author recognizes their existence in thallophytes only. As to the theory of the permanence of the chromosome Dr. Davis says 'it can hardly be said that the doctrine is established.'

In passing we note that the author regards the plasmodium of the slime molds as a coenocyte, and further that coenocytes of all kinds are to be regarded as multinucleate cells, and therefore units, instead of compound structures whose cells have not become separated by walls.

In the last article (IV.), devoted to cell unions and nuclear fusions, the author draws a sharp line of distinction between those which are sexual and those which are asexual. Under the latter (asexual) he includes the fusions of amoeboid cells to form plasmodia, the nuclear fusions in the teleutospores of smuts and rusts, and the nuclear fusions connected with 'double fertilization.' The remaining articles of this instructive publication will be looked for with keen interest.

LEAF INTUMESCENCES.

IN the Sixteenth Annual Report of the Missouri Botanical Garden Dr. Hermann von Schrenk contributes an article on the interesting problem of the cause of intumescences

which sometimes occur on the leaves of various plants. After a historical discussion of leaf-intumescences as observed by other investigators, the author describes the experiments which he made by spraying cauliflowers with various chemical substances. He found that by using ammonium copper carbonate he could produce intumescences at will, varying from minute papillae to large wart-like excrescences, dependent upon the size of the drops of the spray. Sections of these artificially produced intumescences showed that the mesophyll cells had become enormously enlarged, first lifting up, and later rupturing the epidermis. The giant cells were very thin-walled, and occurred in hair-like rows in which the outer cells soon died and became filled with air, while in those lying deeper 'very much reduced chlorophyll grains could be found.'

By means of careful experiments the author concludes that the peculiar growth of these cells is due to chemical stimulation of a kind hitherto unrecorded. Attention is directed to the fact that somewhat similar intumescences containing giant cells are formed as a result of insect punctures, which it is surmised are due to 'some chemical influences exerted by the parent insect, the egg, or the larva.' It is to be hoped that the experiments which the author has now in progress may throw additional light upon this interesting subject, especially the connection between these chemically produced giant cells and those produced in insect galls.

THE CALIFORNIA POPPIES.

Dr. E. L. Greene, of the United States National Museum, publishes a revision of the California poppies (species of *Eschscholtzia*) in the June number of *Pittonia*. The paper is a continuation of work begun more than twenty years ago, and continued from that time to the present. The result is somewhat startling, even in this day of many species of hawthorns and violets. We may well repeat the author's remark, 'that the species are so numerous, one might well regret,' which he follows with this his own defense: 'but nature has yielded them, doubtless even more of them than are here enumerated.' All told the paper describes 112 species, about three fourths of which are described here for the first time. More than two thirds of all the species enumerated are annuals.

THE SMUT-FUNGI OF NORTH AMERICA.

Under the title of 'North American Ustilagineae' Dr. G. P. Clinton publishes in the *Proceedings of the Boston Society of Natural History* (Vol. 31, No. 9) a paper of two hundred pages on the systematic botany of the smut-fungi of North America. The paper is the result of ten years of work (the last two years in the cryptogamic laboratory of Harvard University), during which the author has engaged in: (1) economic studies of the species found in Illinois, published in bulletins 47 and 57 of the Illinois Agricultural Experiment Station; (2) systematic studies, of which the present paper is the outcome; (3) the distribution of exsiccati, one century of which appeared in January, 1903; (4) spore germination studies, now under way.

In the present paper the specific descriptions are based upon the author's examination of the available material, which includes practically all of the European and American exsiccati. This insures a broader treatment than the order has hitherto received at the hands of fungologists. It is significant of the conservative tendencies of the author that although he describes 205 species and varieties, he finds it necessary to make but nine new species. Nor does he find it necessary to erect any new genera, so that his 'new names' are but three.

The order includes two families, Ustilaginaceae, represented by *Ustilago* (72 species), *Sphacelotheca* (16), *Melanopsichium* (1), *Cintractia* (14), *Schizonella* (1), *Mycosyrinx* (1), *Sorosporium* (9), *Thecaphora* (9), *Tolyposporella* (8), *Tolyposporium* (2), and *Testicularia* (1); and Tilletiaceae, represented by *Tilletia* (19 species), *Neovossia* (1), *Tubercinia* (2), *Urocystis* (12), *Entyloma* (127), *Burrillia* (3), *Doassansia* (11), and *Tracya* (1).

An admirable specific systematic list of host plants; a table showing the distribution of our species in other countries; a list of the more

important articles relating to the smut-fungi, and a full index complete this important contribution to our knowledge of this group.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

ARCHEOLOGICAL NOTES.

ICHTHYOLOGICAL NAMES.

MUCH attention was given by the older ichthyologists, notably Conrad Gesner, Rondelet, Artedi, Linné and Cuvier, to classical names of fishes, and their identification with well-known forms. In this country Louis Agassiz, upon the occasion of his rediscovery of *Parasilurus aristotelis* (*Proc. Amer. Acad.*, III., p. 325), was one of the first to bring home the importance of comparing ancient and modern vernacular names of plants and animals, his remarks being ably seconded by a later communication from Professor Sophocles in the same volume.

Within recent years President Jordan and H. A. Hoffmann[1] have attempted a thoroughgoing revision of classic and modern designations of the Hellenic fish fauna, overlooking, however, some of the best work that has been done by their predecessors in this field. For instance, they seem to have taken no heed of the extremely valuable historical and bibliographical works of Artedi, nor of the indispensable commentaries of A. Koraes on the fishes mentioned by Galen and Xenocrates. *À propos* the last-named author, we owe to Koraes the correction of Artedi's error in confusing the physician Xenocrates with the illustrious philosopher of the same name who flourished, as the Swedish naturalist gravely tells us, '*anno mundi 3630, circiter.*'

Amongst the numerous attempts that have been made to identify Aristotelian species, two or three are of superior merit. These are the 'Index Aristotelicus,' published by the Berlin Academy, Aubert-Wimmer's 'Aristoteles Tierkunde' (Leipzig, 1868), and Sundevall's 'Thierarten des Aristoteles' (Stockholm, 1863). A work that might serve as a model for a revised *Synonymia Piscium Græca,* apart from the author's peculiar ideas on animal symbolism, is D'Arcy W. Thompson's 'Glossary of Greek Birds' (Oxford, 1895). Writing in the same year, H. Lewy argues very plausibly for a Semitic origin of a great many Greek names of plants and animals, including fishes. Thus, when we say tunny, carp, chameleon, etc.,—though Mark Twain can not consistently allow this—we approach pretty closely to the speech of Adam. Other contributions of real value that deal with the etymology of the Greek fauna are the following: Nicolas C. Apostolides, 'La pêche en Grèce' (Athens, 1883); T. de Heldreich, 'La faune de Grèce' (Part I., Athens, 1878); D. Bikélas, 'Sur la nomenclature de la faune grecque' (1878), and Dr. Erhard's 'Fauna der Cycladen' (Leipzig, 1858). Finally attention may be called to the newly discovered Byzantine 'Fish Book,' a work dating presumably from the thirteenth century, for the elucidation of which scholars are indebted to Professor Krumbacher, of Munich.

Before leaving this subject, there is one feature in Homeric zoology which deserves notice. Fish, the great delicacy of Attic days, never enters into the diet of the great chiefs, who partake of great meals of roast meat in contradiction of all that we know of any historical Greeks, as Professor Mahaffy has shown, from the earliest to the present day. Even the early athletes trained on cheese, and the people were probably never a meat-eating race. The Dublin professor is inclined to believe, with all its implied significance respecting authorship, that the exclusion of fish from Homeric banquet scenes is 'a piece of deliberate archaism.

PREHISTORIC DARWINIANS.

ZELLER and Osborn have critically investigated the extent to which evolutionary ideas were developed among Ionian philosophers several centuries before our era, and it is doubtful if their main conclusions can be controverted. One must marvel, therefore, at the fertile ingenuity of a French writer, M. Henri Coupin,[2] who has out-Champollioned Cham-

[1] 'A Catalogue of the Fishes of Greece,' etc., *Proc. Acad. Nat. Sci. Phila.*, 1892, pp. 231–285.

[1] J. P. Mahaffy, 'Problems in Greek History,' p. 49 (London, 1892).

[2] 'Le poulpe et la croix gammée,' *La Nature*, May 20, 1905, p. 396.

pollion in deciphering for us records which purport to show the prevalence of evolutionary ideas amongst Pelasgian races upwards of 2,000 years before Christ.

Compared with this feat of modern philologists, the reading of the handwriting on the wall, or of cuneiform inscriptions, is as mere child's play, for in the present case the records that have come down to us from proto-Mycenæan times are neither written nor inscribed. They are different from the papyrus rolls obtained at Herculaneum, although, like them, they have lain buried for ages in the spot aptly termed by Fouqué a 'prehistoric Pompeii' (Thera). In what form, then, are the records? Vase-paintings, scenes and symbols represented on *objets d'art*,—in a word, pictographs! But we may read even picture-writing, provided only we have the key. This M. Coupin triumphantly declares he has found: "Avec cette clef," says he, "on peut lire sans difficulté une foule de petits 'rébus' que personne ne comprendrait sans elle." The key is furnished by a new interpretation of the swastika, a design which has been exhaustively discussed in this country by Thomas Wilson, in the Smithsonian Report for 1894, and more recently by Mrs. Zelia Nuttall. That it is capable of unlocking terrible and profound mysteries may be judged from the following specimens of M. Coupin's 'translation':

> On this bronze fibula (Fig. 11) one reads from right to left: 'From aquatic animals (fishes), through the generative force of the sacred octopus, birds are descended.' On another design: 'Birds have issued from the water by virtue of the sacred octopus, or by a virtue analogous to that of the sacred octopus. * * *'

Already we have had to endure learned disputations tending to show that the far-famed Polyphemus was founded upon seamen's accounts of the gorilla, the present habitat of that animal affording no difficulties to the theorist; and within the last year or two, all semblance of discrimination has been abandoned by certain German writers in their interpretations of Homer's Scilla. Now that we have encountered Darwinism in full swing something like forty centuries ago, it remains only to bring to light a Coptic version of the nebular hypothesis, or a table of lunar distances from the ruins of Yucatan. Through abuses, even a good method may be brought into undeserved reproach; and this seems to be strikingly true of mythological interpretation.

NAMES OF THE GORILLA AND ORANG-OUTAN.

THE discussion by Mr. Forbes in *Nature* (LXIX., p. 343) on the derivation and proper form of the word *orang-outan,* which in Malay means 'forest-man,' leads one to inquire why the specific name of the gorilla, first bestowed upon it by Savage in 1847, should have become almost universally superseded by the title subsequently proposed by Owen. Authors who agree with Owen in regarding this ape as generically distinct from the chimpanzee employ the designation *Gorilla* for the genus, but not for the species. Thus, Huxley in his 'Natural History of Man-like Apes,' and Flower and Lydekker in their treatise on 'Mammals' refer to it as *Gorilla savagei.* On the other hand, the older views of Wyman and Savage are endorsed by such expert mammalogists as P. L. Sclater and Arthur Keith, who defend the appellation of *Anthropopithecus gorilla* (Savage).

It seems to be pretty clearly established that only one species of the gorilla is known, the scientific discoverer of which was Savage; and to this species only one name is applicable, which is that which has become everywhere familiar in popular usage. The story of the origin of the name is interesting, since it harks back to the voyage of Hanno, the famous Carthaginian navigator of the fifth century before our era. There is not the slightest reason for discrediting the narrative of the 'gorillas,' as related in the *Periplus,* Pliny confirming the fact that their skins were exhibited in Carthage, and nearly all authorities agreeing that the southernmost limit of the expedition, where these animals were taken, was only a few degrees above the equator. But the identification of Hanno's 'gorillas' with anthropoid species now inhabiting equatorial Africa is a more difficult matter, though it appears certain they were not the apes which

we are accustomed to understand by this name, or to which Battell gave the name of Pongo, or 'greater monster.' They are supposed by many to have been chimpanzees.

C. R. EASTMAN.

HARVARD UNIVERSITY.

WORK OF THE DEPARTMENT OF TERRESTRIAL MAGNETISM OF THE CARNEGIE INSTITUTION OF WASHINGTON FOR 1905.

Office Work.

I. *Continuation of the study of the secular variation* and compilation of data and preparation for publication on a comprehensive, uniform plan. [The investigations have already progressed far enough to have warranted beginning at once the observational work referred to below.]

II. Discussion and publication of the data on the *magnetic perturbation* observed during the *eruption of Mont Pelée,* Martinique, 1902. [It is hoped to have this work in published form by end of year.]

III. *A general study of the laws of the diurnal variation* to serve as the basis for determining corrections and their reliability for the reduction of field observations.

IV. *Special investigation of magnetic storms* with the view of determining a working method for the discussion and analysis of such fluctuations. [These studies are being conducted under the direction of Professor Adolf Schmidt, at Potsdam, with the aid of funds supplied by the department. Professor Schmidt hopes to be able to contribute a paper on the subject towards the close of the year.]

V. Continuation of a *card catalogue* of publications and investigations in terrestrial magnetism and terrestrial electricity and allied subjects and collecting of information of work done and being done so as to avoid as far as possible needless duplication.

Field Work.

In pursuance of the plan for the completion of a general magnetic survey of the accessible regions of the globe within a period of fifteen to twenty years and of the general investigation of the secular variation, the following observational work is now in actual progress. In all likelihood, the requisite funds for this vast undertaking will be supplied chiefly by the Carnegie Institution of Washington, and in fact it is the expectation that the operations under the auspices of this institution will probably cover about three fourths of the total area to be surveyed. However, the successful execution of the plan requires the harmonious cooperation and concerted action of all civilized countries; accordingly, definite steps in this direction will be formulated in conformity with the advice of leading investigators.

A. *Magnetic Survey of the North Pacific Ocean.*—A wooden sailing-vessel, the brig, *Galilee,* of San Francisco, built in 1891, length 132.5 feet, breadth 33.5 feet, depth 12.7 feet, displacement about 600 tons, carrying a crew of eight men and sailing-master, has been chartered and is now being fully adapted for the purposes of the expedition.

The scientific leader and commander of the vessel—Mr. J. F. Pratt—is one of the most efficient officers of the United States Coast and Geodetic Survey. Commander Pratt has had thirty years' experience in astronomical, geodetic, hydrographic and magnetic work, and has had command both of sailing-vessels and of steamers engaged in coast-survey work. By the courtesy of the Secretary of Commerce and Labor and the Superintendent of the Coast and Geodetic Survey he has been granted the necessary furlough and will enter the temporary employ of the Carnegie Institution for the purpose of assisting in the inauguration of the magnetic survey of oceanic areas. The other members of the scientific corps will be Dr. J. Hobart Egbert, magnetic observer, surgeon and naturalist, and Mr. J. P. Ault, magnetic observer.

The first cruise will be in a region where the various methods to be employed can fully be tested and controlled, viz.: San Francisco, San Diego, Honolulu, Umanak, Aleutian Islands, Sitka. The magnetic elements are to be determined as follows: Declination by two compasses (a liquid one and a dry one) using various azimuth devices, horizontal intensity by a new method being devised which,

by some trials already made, appears promising, total intensity and dip with an L. C. dip circle. The expedition expects to leave San Francisco about the middle of July of this year. [It is gratifying to report that the German government has assured the president of the Carnegie Institution that its Samoan magnetic observatory will be maintained until 1909, to assist in the magnetic survey of the Pacific Ocean.]

B. *Land Work.*—Mr. J. P. Ault, magnetic observer, while temporarily assigned on the coast-survey steamer *Bache,* for securing the necessary training in magnetic work on a cruise from Baltimore to Panama, besides taking part in the sea work, has determined the three magnetic elements at the following stations: Norfolk (Virginia), Key West and Miami (Florida), Kingston (Jamaica), Colon (Panama), Havana, Mantanzas, Batabano and Pinar del Rio (all in Cuba) and Valdosta (Georgia). At Havana comparisons were also made with the instruments of the Colegio de Belen. Thus, most important secular variation and distribution data have been obtained.

Mr. D. C. Sowers, magnetic observer, accompanied the new coast-survey steamer *Explorer* from Baltimore to Porto Rico, determined the magnetic elements on land at Norfolk (Virginia), San Juan and Vieques (Porto Rico), and took part in the sea work. He is now engaged in determining the magnetic elements on various islands of the Lesser Antilles. Mr. G. Heimbrod, surveyor, of Suva, Figi Islands, enters the employ of the department the coming August, as magnetic observer. After assisting Dr. Franz Linke, in charge of the German magnetic observatory at Apia, Samoa, and securing the necessary experience in magnetic and electric work, he will be engaged in determining the magnetic elements on various islands in the South Pacific.

Definite arrangements are furthermore being perfected for securing in the near future observations along the coasts in Canada, Mexico, Central American countries, South America and China, while the oceanic survey is progressing. The precise details will be published later.

[In connection with above work it has become essential to make some experimental investigations at Washington, with the special view of ascertaining the cause of outstanding instrumental differences, and the reliability in the application of corrections derived by comparison, and the changes in the corrections for any particular set of instruments when used in various magnetic latitudes. These studies have an important bearing upon the inter-comparison and reduction of observatory standards, as well as the standardization and testing of instruments designed for field use.]

C. *Eclipse Work.*—Besides the cooperation already promised in the proposed magnetic and electric work during the eclipse of August 30, 1905, the department will have a station of its own at Palma, Majorca Island. The atmospheric electricity observations will be made by Professors Elster and Geitel and Dr. Harms. It will also have one or two stations in Canada, as may be necessary. Mr. J. E. Burbank, magnetician, will have charge of the work in atmospheric electricity in this country, and with that purpose in view has spent three months in Germany with Professors Wiechert, Elster and Geitel familiarizing himself with methods and perfecting the instrumental outfit.

D. *Magnetic Disturbances.*—For studying the correlation between solar phenomena and magnetic disturbances, cooperative work has been entered into between the Solar Observatory and the department of terrestrial magnetism of the Carnegie Institution. Two direct recording variometers, giving a visible record of the magnetic fluctuations and ringing an alarm for disturbances of a certain magnitude, are now being constructed under the direction of Dr. W. G. Cady, research magnetician, in accordance with his design.

Should the device prove successful, additional instruments will be constructed by the department and supplied to institutions ready to cooperate.

[This is the initial step towards the working out of a general plan for enlisting in magnetic work the cooperation of certain favorably situated and well-established institu-

tions, such as astronomical observatories, for example, in order to assist in bringing about a more uniform distribution than prevails at present, of stations contributing magnetic data.]

In the near future *additional appointments are to be made* in the department, the salaries ranging from $1,000 to $2,500 per annum, in accordance with qualifications and position.

The places to be filled call for a chief physicist, experienced magneticians capable of conducting investigations, magnetic observers for sea and land duty, and computers.

The appointments are not restricted to citizens of the United States.

Applications should contain full information regarding the applicant's life, education and experience. They may be sent in now and should be addressed to the Director, Department Terrestrial Magnetism, The Ontario, Washington, D. C., U. S. A.

L. A. BAUER,
Director.

May 25, 1905.

PRESIDENT ROOSEVELT ON THE REWARDS OF SCHOLARSHIP.[1]

THE general opinion of the community is bound to have a very great effect even upon its most vigorous and independent minds. If in the public mind the career of the scholar is regarded as of insignificant value when compared with that of a glorified pawnbroker, then it will with difficulty be made attractive to the most vigorous and gifted of our American young men. Good teachers, excellent institutions and libraries are all demanded in a graduate school worthy of the name. But there is an even more urgent demand for the right sort of student. No first-class science, no first-class literature or art, can ever be built up with second-class men.

The scholarly career, the career of the man of letters, the man of arts, the man of science, must be made such as to attract those strong and virile youths who now feel that they can only turn to business, law or politics. There is no one thing which will bring about this desired change, but there is one thing which will materially help in bringing it about, and that is to secure to scholars the chance of getting one of a few brilliant positions as prizes if they rise to the first rank in their chosen career. Every such brilliant position should have as an accompaniment an added salary, which shall help indicate how high the position really is; and it must be the efforts of the alumni which can alone secure such salaries for such positions.

As a people I think we are waking up to the fact that there must be better pay for the average man and average woman engaged in the work of education. But I am not speaking of this now; I am not speaking of the desirability, great though that is, of giving better payment to the average educator; I am speaking of the desirability of giving to the exceptional man the chance of winning an exceptional prize, just as he has the chance to do in law and business.

In business at the present day nothing could be more healthy than an immense reduction in the money value of the exceptional prizes thus to be won; but in scholarship what is needed is the reverse. In this country we rightly go upon the theory that it is more important to care for the welfare of the average man than to put a premium upon the exertions of the exceptional. But we must not forget that the establishment of such a premium for the exceptional, though of less importance, is nevertheless of very great importance. It is important even to the development of the average man, for the average of all of us is raised by the work of the great masters.

It is, I trust, unnecessary to say that I appreciate to the full the fact that the highest work of all will never be affected one way or the other by any question of compensation. And much of the work which is really best for the nation must from the very nature of things be non-remunerative as compared with the work of the ordinary industries and vocations. Nor would it ever be possible or desirable that the rewards of transcendent success in scholarship should even approximate, from a monetary standpoint, the rewards in other vocations.

[1] From his address to the alumni of Harvard College.

But it is also true that the effect upon ambitious minds can not but be bad if as a people we show our very slight regard for scholarly achievements by making no provision at all for its reward. The chief use of the increased money value of the scholar's prize would be the index thereby afforded of the respect in which it was popularly held.

The American scientist, the American scholar, should have the chance at least of winning such prizes as are open to his successful brother in Germany, England or France, where the rewards paid for first-class scholarly achievements are as much above those paid in this country as our rewards for first-class achievement in industry or law are above those paid abroad.

But of course what counts infinitely more than any possible outside reward is the spirit of the worker himself. The prime need is to instill into the minds of the scholars themselves a true appreciation of real as distinguished from sham success. In productive scholarship, in the scholarship which adds by its work to the sum of substantial achievement with which the country is to be credited, it is only first-class work that counts. In this field the smallest amount of really first-class work is worth all the second-class work that can possibly be produced; and to have done such work is in itself the fullest and amplest reward to the man producing it.

We outsiders should according to our ability aid him in every way to produce it. Yet all that we can do is but little compared to what he himself can and must do. The spirit of the scholar is the vital factor in the productive scholarship of the country.

MR. ROCKFELLER'S ENDOWMENT FOR HIGHER EDUCATION.

At a meeting of the General Education Board, held on June 30, a gift of ten million dollars was announced from Mr. John D. Rockefeller, as an endowment for higher education in the United States. The announcement of the gift was made in a letter from Mr. Frederick T. Gates, Mr. Rockefeller's representative, which reads as follows:

I am authorized by Mr. John D. Rockefeller to say that he will contribute to the General Education Board the sum of $10,000,000, to be paid October 1 next in cash, or, at his option, in income producing securities, at their market value, the principal to be held in perpetuity as a foundation for education, the income, above expenses and administration, to be distributed to or used for the benefit of such institutions of learning at such times, in such amounts, for such purposes and under such conditions, or employed in such other ways as the Board may deem best adapted to promote a comprehensive system of higher education in the United States.

Dr. Wallace Buttrick, one of the secretaries of the board, in a statement concerning the gift, says:

John D. Rockefeller, jr., with others in this city, was instrumental in forming the General Education Board in February, 1902. A very broad and admirable charter was secured from Congress, and signed by President Roosevelt on January 12, 1903.

A gift of one million dollars from Mr. John D. Rockefeller was immediately passed over to the Board, especially designated for educational work in the South. Other funds have been added by other philanthropists since that time, and the Board has confined its work hitherto mainly to educational work in the Southern States.

The present gift differs from Mr. Rockefeller's first gift to the Board in the following particulars: The principal sum of the gift of one million dollars made on the organization of the Board could be distributed. The present gift of ten million dollars is held as endowment, the income only being available for distribution. The first gift was designated to be used exclusively in the Southern States. The present gift is for use not only in the Southern States, but throughout the United States, without distinction of section. The first gift could be used for common schools and secondary education. The second gift is confined to higher education and is designed specially for colleges as distinguished from the great universities, although there is no prohibition in the letter of gift against making contributions to universities.

Both gifts are alike available for denominational schools, as well as for those which are nonsectarian. While the funds may be employed for denominational schools, they will be employed without sectarian distinctions. No special denomination will be particularly favored, but the funds

will be open to approved schools of all denominations, although they can not be employed for giving specifically theological instruction.

In distributing the funds the board will aim especially to favor those institutions which are well located and which have a local constituency sufficiently strong and able to insure permanence and power. No attempt will be made to resuscitate moribund schools or to assist institutions which are so located that they can not promise to be permanently useful.

Within these limits there are no restrictions as to the use of the income. It may be used for endowment, for buildings, for current expenses, for debts, for apparatus, or for any other purpose which may be found most serviceable.

It is known that Mr. Rockefeller has had this gift in contemplation for a long time, and Mr. Gates has been studying the subject in his behalf for many months. If the fund proves to be as useful as is now anticipated Mr. Rockefeller will undoubtedly make large additions to it in future years.

The present members of the board are as follows: Robert C. Ogden, chairman; George Foster Peabody, treasurer; Wallace Butterick, secretary and executive officer for the states south of the Potomac and Ohio Rivers, and Arkansas, Louisiana and Texas; Starr J. Murphy, secretary and executive officer for the states of the north and west; Frederick T. Gates, Daniel C. Gilman, Morris K. Jesup, Walter H. Page, Albert Shaw, John D. Rockefeller, Jr., Hugh H. Hanna, William R. Harper and E. Benjamin Andrews. There are four vacancies in the board which are expected to be filled later.

HONORARY DEGREES AT HARVARD UNIVERSITY.

AT the recent commencement Harvard University conferred seven honorary degrees. Those given to men of science, with the remarks made by President Eliot, were as follows:

Honorary Master of Arts.—Frederick Pike Stearns—chief engineer of the Metropolitan Water and Sewerage Board, with special charge of the waterworks, immense works in earth, masonry and metal, ten years in construction, planned and executed with good judgment, boldness and long foresight, and with demonstrated success as regards the adequacy, purity and reasonable cost of the supply.

Honorary Doctor of Science.—James Homer Wright—pathologist, both teacher and investigator, strong contributor to the advance of that biological science which holds out to mankind good promise of deliverance from mysterious evils long endured.

Doctors of Laws.—Henry Marion Howe—a Boston Latin School boy, Harvard bachelor of arts and Institute of Technology bachelor of science, an author on copper, iron and steel, distinguished for scientific imagination and a good English style, professor of metallurgy in Columbia University, consulting metallurgist honored by the profession in England, France, Germany, Russia and his native land. Reginald Heber Fitz—for thirty-five years a teacher of pathological anatomy and of the theory and practise of physic, skilful and acute diagnostician, much trusted consulted physician, sagacious contributor to the progress of medicine.

SCIENTIFIC NOTES AND NEWS.

YALE UNIVERSITY has conferred its doctorate of science on Professor George E. Hale, director of the Solar Observatory of the Carnegie Institution, and on Dr. T. W. Richards, professor of chemistry at Harvard University, and its degree of doctor of laws on Dr. Abraham Jacobi, emeritus professor of the diseases of children at Columbia University.

DARTMOUTH UNIVERSITY has conferred its doctorate of laws on Dr. C. L. Dana, a graduate of the class of '72, professor of nervous diseases in the Cornell Medical School.

DR. LUDWIG BOLTZMANN, the eminent mathematical physicist of Leipzig, arrived at Berkeley on June 26, where he will lecture before the summer school of the University of California.

PROFESSOR PAUL EHRLICH, of Frankfort-on-Maine, and Professor Ramón y Cajal, of Madrid, have been elected foreign associates of the Paris Academy of Medicine.

Dr. Julius Wiesner, professor of botany at Vienna, has been elected a member of the Danish Academy of Sciences.

Professor H. S. Graves, of the Forest School of Yale University, has returned to New Haven after his trip around the world. He paid special attention to forest conditions in India.

Dr. Arthur Schuster, professor of physics at the University of Manchester, has been nominated by the council of the Royal Society as one of their representatives on the committee of management appointed by the treasury for the Meteorological Office in London. He has also been elected as a representative of the council of the Royal Society on the council of the International Association of Academies.

By a unanimous vote of the board of trustees of the University of Pennsylvania the Rev. Dr. Hermann Vollrat Hilprecht, research professor of assyriology and professor of semitic philology and archeology of the University of Pennsylvania, was on June 27 acquitted of the charges recently brought against him concerning his integrity in the matter of his explorations in Babylonia.

M. Perrier has been reappointed for five years director of the Paris Museum of Natural History.

Mr. J. J. Lister, M.A., Fellow of St. John's College, Cambridge, has beeen nominated to occupy the university table at the laboratory of the Marine Biological Association at Plymouth.

Sir John Wolfe Barry has been elected to succeed the late Mr. James Mansergh as chairman of the British Engineering Standards Committee.

At the recent commencement at Union College, Schenectady, N. Y., the honorary degree of doctor of science was conferred on Olin H. Landreth, professor of engineering at that institution and consulting engineer of the New York State Board of Health.

At its thirty-eighth annual commencement Muhlenberg College conferred the degree of doctor of science on Professor Lewis M. Haupt, formerly of the U. S. Corps of Civil Engineers and late of the Nicaragua and Panama Canal Commission.

The degree of doctor of laws was conferred upon Professor John C. Hemmeter of Baltimore by St. John's College, Annapolis on June 21. In his address at the convocation exercises, Professor Hemmeter advocated the affiliation of St. John's College with the professional schools (medicine, law, dentistry, pharmacology) of the University of Maryland. In 1784 both these institutions formed a federation into the University of Maryland, which ceased to exist by the act of 1825. Professor Hemmeter is also in favor of including the Maryland Agricultural College (already largely owned and administered by the state) in the affiliation as the 'School of Agriculture and Technology' of the University of Maryland.

Mr. W. R. Sorley, M.A., of King's College, Cambridge, Knightbridge professor of moral philosophy, has been approved by the general board of studies for the degree of doctor in letters.

The De Morgan medal of the London Mathematical Society has this year been awarded to Dr. H. F. Baker, F.R.S., for his researches in pure mathematics.

The Hamburg prize for promoting progress in chemistry and pharmacognosy has been awarded this year to Professsor E. Schmidt of Marburg. The presidents of the British Pharmaceutical Society, the Chemical Society and the Linnean Society are members *ex officio* of the committee in charge of this biennial prize.

Mr. James Mansergh, F.R.S., a British engineer, well-known for his work on water-supply and sewage, died on June 15.

The University of the State of New York held its forty-third annual convocation at Albany on June 28, 29 and 30. The meeting was devoted to a discussion of industrial, commercial and agricultural education. Among those who took part were President Edmund J. James, of the University of Illinois; Mr. Robert T. Ogden, of New York; Mr. Frank A. Vanderlip, of New York; Professor J. W.

Jenks, of Cornell University, and Dean W. A. Henry, of the Wisconsin Agricultural Experiment Station.

INFORMATION from Ottawa states that the Dominion Astronomical Observatory has been practically completed. The telescope has been mounted, astronomer W. F. King, with his staff, has taken possession of the building and observation work has begun. The telescope is a refracting instrument 19 feet 6 inches long, with a 15-inch lens. In addition to the telescope, the observatory has transit spectroscopic instruments and the equipment of a first-class institution. The building cost $92,000 and the telescope $14,000.

AN astronomical observatory, to be known as the Cecil Duncombe Observatory, is to be established in connection with the University of Leeds. A building with an aluminium dome is being built at one of the highest points in the city, and in it will be placed the telescope recently presented to the university by Captain C. W. E. Duncombe, together with the transit instrument presented by the late Mr. W. E. Crossley.

DURING the present season the U. S. Geological Survey will undertake work in Alaska, as follows: An investigation of the gold placers of Beaver Creek will be made by Mr. R. W. Stone. The ore deposits of Berners Bay will be studied by Mr. C. W. Wright, those of the Ketchikan district and the Wrangell region by Messrs. F. E. and C. W. Wright. Stratigraphic and paleontologic investigations will be carried on in southeastern Alaska by Mr. E. M. Kindle in cooperation with Mr. F. E. Wright. The coal fields of Herendeen Bay will be investigated by Mr. Sidney Paige, who will also prosecute economic and stratigraphic studies on Kodiak Island. Mr. U. S. Grant, assisted by Mr. Paige, will make a geologic reconnaissance of the country about Prince William Sound and will investigate its mineral resources. A geologic reconnaissance of the Matanuska coal fields will be made by Mr. G. C. Martin. In the Nome region Messrs. F. H. Moffit and F. L. Hess will study the geology and mineral resources. They will also investigate the more important placer districts of Seward Peninsula, and Mr. Hess will examine the tin deposits of the York region. A geologic reconnaissance of the country around Yakutat Bay will be made by Professor R. S. Tarr, who will be assisted by Messrs. B. S. Butler and Lawrence Martin. A geologic reconnaissance in the Yukon-Tanana region, between Dawson and Fairbanks, will be undertaken by Messrs. L. M. Prindle, assisted by Mr. A. Knopf. Geologic and topographic surveys and investigations of mineral resources will be supervised by Mr. A. H. Brooks in southeastern Alaska, about Controller Bay, in Matanuska region, about Yakutat Bay, on Alaska Peninsula, Seward Peninsula, and in the Yukon-Tanana region. Geologic and topographic surveys of the country around Controller Bay will be made by Messrs. G. C. Martin, and A. G. Maddren, geologists, and Messrs E. G. Hamilton and W. R. Hill, topographers. A detailed topographic survey of the Solomon River region will be made by Mr. T. G. Gerdine, assisted by Messrs. W. B. Corse and B. A. Yoder. Topographic and geologic surveys will be made west of Fairbanks between Circle City and Chena by Messrs. D. C. Witherspoon and R. B. Oliver, topographers, and Mr. R. W. Stone, geologist.

DURING the field season of 1903, Mr. George C. Martin, of the United States Geological Survey, made an examination of the petroleum and coal fields in Alaska. A brief preliminary report of this investigation was included in a bulletin published by the survey last year. The final complete report is now available as Bulletin 250, under the title of 'The Petroleum Fields of the Pacific Coast of Alaska, with an Account of the Bering River Coal Deposits.' Indications of petroleum have been found in the Controller Bay, the Cooke Inlet and the Coal Bay regions. Though only a few wells have been drilled and it is too soon to predict an important future for the region as a petroleum producer, Mr. Martin's studies have shown that there is justification for further prospecting and that the region may yet be a source of illuminating oil. The petroleum is clearly a refining oil of the same general nature as Pennsylvania petroleum.

It resembles the latter in having a high proportion of the more volatile compounds and a paraffin base and in containing almost no sulphur. The Bering River coal, which comes from a field 12 to 25 miles inland from Controller Bay, is the best that has yet been found on the Pacific coast of North America. The coal area, as far as known, is restricted to the region north of Bering Lake and Bering River. It includes about 120 square miles. The physical properties of the coal are very much alike in all the seams and in all parts of the field visited by Mr. Martin. The coal resembles the harder bituminous coals of the east more than it does anthracite. It is doubtful, too, whether much of the coal could be sized so as to compete with anthracite coal for domestic use; and again, under ordinary handling it will probably crush to almost the same extent as the harder grades of semibituminous coal. That will not, of course, impair its value for steam purposes, but will necessitate careful handling if it is to compete with Pennsylvania or Welsh anthracite as a domestic fuel. The illustrations that accompany the report include geologic reconnaissance maps of the Controller Bay region and Cook Inlet oil field and sketch maps of the Cold Bay and Cape Yaktag petroleum fields, as well as an outline map showing the general location of the oil fields and the areas represented on the large-scale maps.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. JOHN D. ROCKEFELLER has given $1,000,000 to Yale University; other large gifts have been made towards the endowment fund of the university, the details of which have not been announced.

MR. STEPHEN MOODY CROSBY, Dartmouth, '49, of Boston, has given $50,000 to the college toward the building fund. It was planned to raise $250,000 for this purpose, and Mr. Crosby's contribution completes that amount.

AT a meeting of the board of trustees of the Iowa State College on June 7 at Ames, it was voted to confer the degree of bachelor of agricultural engineering on students who complete a prescribed course in this subject. Graduates of either engineering or agricultural courses are eligible after the completion of one year's advanced work. The Iowa State College is the first institution in America to organize comprehensive instruction in this line and prepare to confer the degree. Forty-nine agricultural students were graduated at Ames from the four year course in animal husbandry, agronomy, dairying and horticulture in the last class, including five who took advanced degrees.

PROFESSOR E. H. MOORE, of the University of Chicago, and Professor J. Mark Baldwin, of the Johns Hopkins University, are giving courses of lectures on mathematics and psychology, respectively, in the summer school of the University of California.

THE following appointments in the Sheffield Scientific School, Yale University, have been announced: assistant professor, Dr. Henry Andrew Bumstead, physics; instructors, Dr. Frank Bell Underhill, physiological chemistry; Mr. Beverly W. Kunkel, biology; Dr. Oliver C. Lester, physics; assistants in instruction, Mr. Clarence C. Perry, steam engine; Mr. Haroutune M. Dadourian, physics; Mr. William A. Lilley, Jr., descriptive geometry and drawing.

DR. K. E. GUTHE, associate physicist at the National Bureau of Standards, has been appointed professor of physics and head of the department of physics at the State University of Iowa.

FREDERICK C. NEWCOMBE has been appointed professor of botany and Charles A. Davis, curator of the herbarium, at the University of Michigan.

MR. ALEXANDER JAY WURTS has received the first appointment to the faculty of the Carnegie Technical Schools, Pittsburg, that of professor and head of department of applied electricity.

M. W. BLACKMAN, Ph.D. (Harvard, 1905), has been made instructor in comparative anatomy and embryology in the medical department of Western Reserve University.

FORREST SHREVE, Ph.D., has been appointed Adams Bruce fellow at the Johns Hopkins University.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, JULY 14, 1905.

CONTENTS.

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE FUNDAMENTAL PROBLEMS OF PRESENT DAY PLANT MORPHOLOGY.[1]

A FEW months ago I was in Jena in order to attend the unveiling of the statue there erected to M. Schleiden. Now there is hardly any other place which has been of so much significance in the development of plant morphology as this small university town. It was there that Goethe, the originator of the term 'morphology,' busied himself with morphological studies, and founded the idealistic system which has influenced our thought—often unsuspectedly—till the present day. There Schleiden, in outspoken opposition to the conceptions of the idealistic morphology, gave new life to the theory of development founded by Caspar Frederick Wolff in a neighboring hall in the middle of the eighteenth century, and so paved the way for the brilliant discoveries of William Hofmeister. And who does not know what meaning Jena has won as the citadel of phylogenetic morphology, first through the work of Haeckel in zoology and later through that of Strasburger in botany? In such a morphological atmosphere the question forces itself upon us, in what relation do the morphological questions of the present stand to those of the past? Are they still unchanged in spite of the immense increase of empirical ma-

[1] Lecture delivered at the Congress of Arts and Science in St. Louis, September 21, 1904, by Professor K. Goebel, University of Munich; translated by Professor F. E. Lloyd. The theme was proposed by the Direction of the Congress. Since the time allowed for the lecture was but forty-five minutes, the various questions could be indicated merely.

terial, and have the methods of their solution only changed? Or have the problems themselves become different?

To reply to this question is not easy, and the answer must vary with the point of view of the one who makes it. For morphology is yet far from being an exact science, the results of which force themselves upon us with the compulsion of necessity. This is due to the difficulty of the materials, a difficulty which compels us to seek for hypotheses and other subjective means of explanation. It thus comes about that views not only concerning the goal of morphology, but also as to the way in which this goal is to be reached, are widely diverse, and my own views concerning the fundamental problems of morphology are certainly far from being approved by all morphologists.

We may, indeed, say that, apart from minor differences, there are in morphology two main trends of thought which, apparently at least, are opposed to each other, one of which we may denominate formal, and the other causal. Causal morphology is that the aim of which is to determine the causes, in the widest sense, of form relations; this kind of morphology is the youngest, and is far less widely diffused than the formal. To us of a later period it may seem like a remarkable pleonasm, to speak of a 'formal morphology.' Morphology is, of course, the doctrine of form, and therefore any morphology appears to be, in the nature of the case, a formal one, and as a matter of fact has been in its historical development. But in spite of this fact this definition is historically justified, for it designates the tendency of morphology which regards form as something which stands alone for itself, and takes cognizance neither of the functions of organs nor of how they have arisen. This formal morphology arose at first out of the necessities of taxonomy. There had first to be contrived a terminology for the distinction and description of single plant forms. From this function morphology soon, however, became distinct, thus constituting an independent discipline which on its part had served taxonomy a more important service than one might have at first expected. For while taxonomy, in order to find its way amid the maze of plant forms, had to keep in view the differential characters and the separation of single forms from each other, morphology found itself under the necessity of determining what was common to the most various forms and was accordingly directed toward more general questions; morphology taught, as Goethe expressed it, 'Die Glieder der Pflanzen im Zusammenhänge zu betrachten, und so das Ganze in der Anschauung gewissermassen zu beherrschen.' It resulted in the knowledge that, when we regard plants singly, manifold as their parts appear, they may yet be referred to a few elementary forms, and further, morphological research showed that the parallelism between different plant forms could be understood most easily under the assumption which we designate the theory of descent. The establishment of the theory of descent was the result of the morphological research. This we must here especially emphasize, for it shows what significance morphology has gained in respect to our general conception of organisms. But the theory of descent has also reacted upon morphological research, to such an extent, indeed, that it has been held that phylogenetic research is to be regarded as the sole business of morphology. Thus, for example, Scott has said:

> The object of modern morphological botany is the accurate comparison of plants, both living and extinct, with the object of tracing their real relationships with one another, and thus of ultimately constructing a genealogical tree of the vegetable kingdom. The problem is thus a purely historical

one, and is perfectly distinct from any of the questions with which physiology has to do.[2]

This position is certainly justified from the standpoint of the paleontologist. For him, for whom nothing but dead material is at hand, there remains nothing else to do than to make known, through careful comparative study, the structure and relationships of those organisms whose remains are available. This is a very important business. The beautiful results of phytopaleontological research, such as have been attained during the last decade in England and France, have very materially furthered our knowledge of plant forms, and have made to live again before our eyes in a most surprising manner and in the finest details of their structure, types long since vanished from the surface of the earth.

But does this limitation of morphology to the comparative phylogenetic method which is imposed upon the paleontologist exist also for the morphological study of living plants?

There are many of the opinion of Scott; and, indeed, a special 'phylogenetic method,' which is said to be a characteristic of modern morphology, has even been talked of.

Were this the case, then the only difference between the morphology of the present and the earlier, idealistic morphology would consist in this, that in the place of the general ideas with which this operates, as, e. g., 'type,' 'plan of organization,' etc., there would be found phylogenetic conceptions. Such general abstractions are, however, even now difficult to escape, since we can set forth real descent-series only in the fewest instances, and, accordingly, we can not actually point out the stem forms. Yet Darwin himself said:

We have seen that the members of the same class, independently of their habits of life, resemble each other in the general plan of their organization. This resemblance is often expressed by the term 'unity of type'; or by saying that the several parts and organs in the different species of the class are homologous. The whole subject is included under the general term of Morphology. This is one of the most interesting departments of natural history, and may almost be said to be its very soul.[3]

The significance of formal morphology can not be more forcibly expressed than it was by Darwin. And yet we see that, in Germany at least, interest in morphological problems has greatly decreased. Morphological treatises have become relatively less numerous; morphological books, even such excellent ones as, *e. g.*, Eichler's 'Blüthendiagramme,' do not pass through a second edition, while anatomical and physiological works appear repeatedly in new editions; evidently meeting the demands of the botanical public more fully than morphological works. This may be referred to reasons which lie partly without and partly within morphology itself; both turn out to be true. Histology, cytology and experimental physiology have developed remarkably; new methods in this field promise new results; particular lines of work, however, such as descriptive anatomy, are especially favored because the perfection of the methods of research have quite materially lightened the task of working through a vast array of materials, especially for those to whom the other fields of botanical study are more or less unfamiliar.

But the reasons for the phenomenon which lie within the field of morphology are also clear. Some parts of morphology are well worked out, as, *e. g.*, the doctrine of the more obvious form relations of plants, and the homologies, at least in the large, are determined, although in the matter of detail much remains vague and offers a wide field for exhaustive studies in development. More and more, however, these

[2] Address to the botanical section, British Association for the Advancement of Science, Liverpool, 1896.

[3] 'Origin of Species,' 2: 142.

studies bear the stamp of repetition and complement, from which the stimulus of newness is wanting, or they are carried on upon materials which are very difficult to obtain. The constructions of the idealistic morphology, however, often proved to be untenable.

But the first experiments towards a causal morphology, brought disillusion. For only a short time lived the hope of being able to answer, *e. g.*, the question as to the arrangement of leaves through the effect of mechanical factors, or to refer the form-relations of a plant to the direct influences of gravity and light on the plant. It soon became evident, however, that such involved problems are not to be unraveled by such simple means, and this may well have resulted in the suppression of interest in morphology.

At this point phylogenetic morphology appeared to take on a new lease of life. This, however, in natural science is connected, on the one hand, with the appearance of a new, creative (?) idea, and, on the other hand, with the discovery of new methods. Now the theory of descent has powerfully stimulated morphological research. But has it brought to it, as, *e. g.*, Strasburger has held, a new method, the phylogenetic? Alexander Braun has already properly answered this question in the negative.

Scott, also, has maintained that historical morphology (as regards both living and fossil plants) is dependent upon comparative study, that is, makes use of the same method as was in evidence before the appearance of the theory of descent; indeed, the most important homologies in the plant kingdom became known through Hofmeister at a time when the idea of descent was far from that general acceptation which it at first gained through the life work of Darwin.

The method has then from first to last remained the same: the most comprehensive comparison not only of mature forms, but also their development. A special 'phylogenetic method' there is not, but only a phylogenetic conception of morphological problems. These are, however, just as at first was the case with idealistic morphology, purely formal. Modern morphology, in my sense, however, differs from the older in this, that it goes beyond the method of mere comparison. It allows the setting up of genetic trees to rest for the while, since, with our present knowledge, this meets with insuperable difficulties and has brought almost as much disappointment as the idealistic morphology. For just this reason, namely, because we are persuaded that no other forces have been at work during the phylogenetic history than those which now control the development of each particular organism, do we wish, first of all, more exactly to learn what these are. We are concerned not alone with the determination of the single successive stages of development. These must, of course, be followed, but in addition we should follow all phenomena which may be got at by our means of observation, whether directly, by the microscope, or by chemical analysis. We may, therefore, say: The basal problem of the present day morphology is not phylogenetic development, but development in general. We must, therefore, take our departure from the investigation of individual development (of ontogeny), for only this lies before us complete and without any break, and further, because the study of ontogeny only may proceed from the experimental point of view. An understanding of development is possible only when the conclusions, to which the observation of the phenomena of development has led us, rest upon experimental proof; in other words, when we ask questions of Nature, and obtain our answers to them.

Every little step—and with such only

are we now concerned—beyond the mere descriptive consideration of development is here of significance, and brings the possibility of further progress. And small indeed, I may add, appears to be such advance to those who, from the beginnings of phylogenetic morphology have, like Sisyphus, sustained their courage to roll again and again up the mountain the rock of phylogeny as often as it has rolled down.

It may now be attempted to examine somewhat more closely in certain particular examples the relation between phylogenetic and causal morphology. One of the changes which phylogenetic morphology has brought with it is that it seeks to ascertain which form is 'primitive' and which derived. Idealistic morphology has borne in upon us no conviction on this question, since it derives all forms from a type which is present only as a conception. But phylogenetic morphology must, on the one hand, always reckon with the possibility of polyphyletic development, and, on the other hand, it can operate not only with reversionary structures, as did the idealistic morphology, but must be far more concerned in determining which forms within the series which it proposes stand nearest the common point of derivation. It seeks then with diligence after 'primitive' forms. But in this search we meet with great difficulties. In the first place, we are inclined to regard those forms as primitive which have simple form-relations, and unmarked division of labor. But such forms may also have arisen by reversion, and if one looks over botanical literature, he sees, at least so far as the relationships between the larger groups are concerned, there exists no agreement as to which forms are to be regarded as primitive and which derived: often opinion on this point changes with the fashion. Thus the thallose liverworts have up till now been regarded as more primitive than the foliose, because the vegetative body of the former is much more simple in construction than that of the latter, and between them there are found gentle gradations. Recently, however, the attempt has been made to derive the thallose from the foliose forms. This is not the place to examine the evidence for or against such derivation. How vacillating is the point of view from which it is judged what form is primitive is shown by the various positions which have from time to time been given to the apetalous dicotyledons.

The old morphology regarded these as reduced forms because their flowers are less fully differentiated than those of most of the other dicotyledons. Eichler has, however, already shown that there is no ground for maintaining that the corolla in the 'Iulifloræ' and 'Centrospermæ' has suffered reduction; and on this point we can only agree with him. But must they, because the perianth shows simpler form relations and also because the number relations within the flower are not always constant, be therefore primitive? Even if we admit that these groups have a great geological age, it is not proved that they stand as regards their total organization on a lower plane of development; old and primitive forms are the same only when it can be shown that the former stand nearer to the stem forms of the angiosperms than other forms. If this is not capable of proof, then the old forms may just as well be the end terms of long developmental series as others, only that the differentiation of organs has not taken place to the same degree as in the others. Now, we do not know the stem forms if the angiosperms, and they may never, perhaps, be known. But even if we content ourselves by reconstructing them on the basis of comparative study, I can find no reason, *e. g.*, to regard the Cupuliferæ as primitive forms, while I can find many reasons for not doing so.

Here may be cited chalazogamy, which elsewhere occurs in forms which may be regarded as degenerate; the facts that only a few of the ovules develop further; that at the time of anthesis they are in many forms not yet present, and finally the dicliny of the flowers. There has been much contention over the question whether the androgynous flowers of these forms are to be admitted to be the original form or not. Let us look at, *e. g.*, the Cupuliferæ. Most of the forms have diclinous flowers. In *Castanea vesca,* however, androgynous flowers occur regularly, and in the male flowers rudiments of the ovary, in the female flowers staminodia are often evident. But we know that for reduced organs all gradations occur from nearly complete development to almost entire disappearance. From the formal standpoint, then, the androgynous flowers may, with at least as much justice, be regarded as primitive as the diclinous ones, which, more recently, have been thus branded. Just this question is, however, fitted to clear up the difference between pure phylogenetic and causal morphology. The latter says: By the mere comparison of forms morphological questions may not at all be decided. We must first of all become more closely acquainted with the forms to be compared, by seeking to determine the conditions under which, in living plants, the configuration of parts is produced. Concerning the flowers of the Cupuliferæ the question then arises: is the occurrence of male and female flowers dependent upon different conditions and are these other than those under which androgynous flowers arise? As a matter of fact, it may be determined that, *e. g.*, in the oak the female flowers always occur in those parts of the twig which are stronger, that is, better nourished than those in which the male flowers occur. This offers us, however, only a point of departure for a more exhaustive research. When we know better the relation between the formation of flowers and the total activity of the plant, when we have the ability at will to cause it to produce male, female or androgynous flowers, when we further know how it is determined that the oak usually brings to development only one out of six ovules, and why the pollen tube follows a different path than the usual, then may we further discuss the question whether the Cupuliferæ are primitive or not—for then shall we have better grounds for phylogenetic conclusions than we have at present, and we shall then recognize with great probability the changes which have taken place in these organs as phenomena resulting from changes in the total organization of these plants.

So, as the matter now stands, we can not deceive ourselves on this point, that the constructions of the old morphology, although confined almost entirely to *vestigial* series, nevertheless stood on firmer ground than the modern speculations on the question of primitive forms. Starting with a completely endowed form, we can follow the reduction of form through intergradations and, by reference to vestigial organs, often with convincing certainty. But by what means shall we judge a rudimentary organ? Is it more than a gratuitous assumption, when, as recently was the case, a certain botanist declares the lodicules of grasses to be not a perigone, but a rudiment (*Ansatz*) of a perigone? Whereby may one recognize a rudiment, *i. e.*, the attempt to form something new, an attempt which, however, has remained nothing more? In what way may we distinguish such a rudiment from a vestigial organ? And, finally, after one has broken faith with the old vestigial series, is it not still more of the stamp of formal morphology if he contents himself in arranging forms in series and then comes to a standstill when he tries to decide at which end

stand the primitive and at which end the derived forms? At any rate, such a limitation brings out the better the true condition of our knowledge, for such an arrangement of forms in a series is about the best service that formal morphology can do. This service is, to be sure, no small one, for it enhances broad critical comparison and is, therefore, the result of hard work. But the desire to give this arrangement in series a genetic bearing has oftentimes led us to untenable propositions and explanations. Just as we have little ground for assigning the Cupuliferæ to a primitive position, so have we as little evidence for regarding the Casuarinæ also in the same light. The latter have been placed by a recent systematist at the apex of his system because there has been an inclination to find in them a sort of 'missing link' between angiosperms and gymnosperms. I may, perhaps, mention that I had regarded such a view as incorrect, even before the evidence was adduced by an American botanist (Frye) that *Casuarina* has evidently nothing which marks it off from other angiosperms. Many of my fellow botanists have been inclined to point out as a further example of the fruitlessness of the search for primitive forms those Bryophytes which have been regarded by me as primitive; and I readily admit that here also we can not point out any conclusive evidence for their primitive position, but only for a greater or less subjective probability. Numerous other examples (as, *e. g.*, the supposed primitive monocotyledons) may be pointed out, which show that the phylogenetic morphology has overrated the prospects of results in search for primitive forms, stimulating as this has been.

This may be seen also if we notice the attitude of phylogenetic morphology to the problem, which the old morphology dubbed with the not very fortunately chosen name of metamorphosis, and which historically is that of homologies. Here, also, it may be shown that the problems have remained the same while only the attempts to reach a solution have changed.

The idealistic morphology believes that all organs of the higher plants may be traced back to caulome, phyllome and trichome; it conceived this process not as a real one, but was content with a conceptual arrangement of different plant organs in these categories, which were really nothing but abstractions.

That thereby the reproductive organs were left entirely out of consideration—these were referred to modifications of vegetative organs—is explained in part by the fact that they occur in the higher plants less frequently as peculiar parts, and often completely disappear in teratological growths, which are with predilection turned to account in theoretical considerations; and in part because of the view that for morphology the function of an organ is a matter of indifference, and that accordingly in morphological considerations it can have no significance whether an organ has developed as a glandular hair, chaffy scale or as an archegonium, so long as it has developed out of the outer cell-layer of the plant body! This standpoint, a complex one, indeed, needs no especial discussion more. Let us, on the other hand, see how phylogenetic morphology has come to terms with the problem of metamorphosis. As an example I select a passage from a prominent American work, in which Coulter and Chamberlain express themselves concerning the leaf structures of flowers as follows:

While sepals and petals may be regarded as often leaves more or less modified to serve as floral envelopes, and are not so different from leaves in structure and function as to deserve a separate morphological category, the same claim can not be made for stamens and carpels. They are very ancient structures of uncertain origin, for it is quite as likely that leaves are transformed

sporophylls as that sporophylls are transformed leaves. * * * To call a stamen a modified leaf is no more sound morphology than to call a sporangium derived from a single superficial cell a modified trichome. The cases of 'reversion' cited are easily regarded as cases of replacement. Lateral members frequently replace one another, but this does not mean that one is a transformation of the other.[4]

We see that in this verdict the emphasis is laid on the historical development, but at the same time this is pointed out to be unknown to us. With this latter conclusion I am in complete harmony, but the accentuation of the historical-phylogenetic factor has, on the other hand, led to a conception of the ontogenetic problem, in which I can perceive no advance upon the old morphology; there is rather avoidance of the problem than an attempt to solve it. This, however, is connected with the purely formal conception, as the phylogenetic morphology employs it. Let us examine the matter in question. For a long time we have known that often in the room of the stamens—to confine ourselves to these—flower leaves or foliage leaves or occasionally even carpels arise. The idealistic morphology says that this proves that the stamens are 'leaves,' for these can be modified the one into the other. Coulter and Chamberlain, however, deny that a stamen fundament may be transformed into a flower leaf; they find only a 'replacement' of one 'lateral member' by another. It should be remarked that 'leaves' exist in nature as little as 'lateral members.' Both notions are mere mental abstractions, not the expression of the facts of observation. We speak of the replacement of one organ by another if these have nothing more in common than the place of origin. Thus we see that in the foliose liverworts a branch often arises in the position of a leaf-lobe. No one has observed any intermediate form between these: the lateral shoot in reality takes only the position of a leaf-lobe. The relation between the stamens and the organs which 'replace' them is, however, quite different. We speak of a transformation of an organ A into an organ B when B not only stands in the position of A, but also corresponds with A in the earlier stages of its development, and later strikes out on its own line of development. If this is the case, we should expect to find between A and B intermediate forms which are different according to the developmental stage at which A is caused to develop further as B. To use an analogy: Replacement and transformation behave as two fluids which are, and two fluids which are not miscible; in the first case the inner structure is different, and in the second there is a correspondence. The comparison is a limping one, but still gives us a fair illustration.

[4] Coulter and Chamberlain, 'Morphology of the Angiosperms,' p. 22.

As a matter of fact, we do find every intermediate step between stamens and flower leaves, and we can not doubt that these have come into existence because a stamen, or, in other words, a stamen fundament, has at different stages of its development received a stimulus which has caused it to develop into a flower leaf. We find correspondingly, that the earlier developmental stages of a stamen and a flower leaf are parallel throughout, while in the above cited example of the branch and a leaf-lobe of a Jungermanniaceous liverwort the developmental history are throughout different, as is shown by the arrangement of cells. In the case of stamens, therefore, there occurs not a replacement, but a transformation. And, indeed, a limited one. Not any 'lateral members' you please may arise instead of stamens, but only and always those which we subsume under the concept leaf, because they evidently have peculiarities in common. Besides, there are also normal flowers which exhibit all intergradations between flower

leaves and stamens. The former Coulter and Chamberlain would regard as leaves, the latter not; where, however, is the line of separation between them?

From the limited power of transformation possessed by organs it results that in causal morphology the problem is then not a phylogenetic, but an ontogenetic one. Whether sporophylls or foliage leaves are the older phylogenetically may be disregarded. For it appears more important first to determine why the power of transformation is limited, why a shoot-thorn or a shoot-tendril may be transformed only into a shoot, a stamen or a carpel only into a 'leaf'; and second, what conditions are determinative thereto.

The first step toward the solution of the problem is that we learn to call out experimentally and at will such transformations as we have heretofore occasionally observed as 'abnormalities.'

This has been successful in experimental morphology in a great number of cases, and in the future will be still more so. To be sure, we are still unable to induce the transformation of stamens into flower leaves at will—we only deceive ourselves when we believe that the art of the plant breeder has succeeded in doing this, for in reality all he has done is to isolate such races which have occurred in nature with more or less doubled flowers—and in this regard we stand in contrast to the fungi and insects, the activities of which, as Peyritsch and others have shown, often—unconsciously of course—call forth such transformations. Yet it has been possible to change scale leaves (cataphylls) and sporophylls into foliage leaves, inflorescences into vegetative shoots and, *vice versa,* plagiotropous into orthotropous shoots, hypogæous into epigæous, not to mention the interesting results which have been obtained by Klebs in his studies of the lower plants.

Let us take, for example, the just mentioned transformations of scale leaves into foliage leaves and of sporophylls into sterile leaves. Here developmental study and experiment immediately encroach on each other. Development has shown that, *e. g.,* the bud-scales of many trees which in their definitive condition are very different from the foliage leaves, yet parallel them developmentally in an extraordinary degree; and that many bud scales possess the fundament of a leaf blade which has failed to develop and has thus become vestigial. Similarly, the fundaments of the foliage leaf and the sporophyll in *Onoclea* are the same up to a quite late stage of development, beyond which each follows its own course. These facts gave occasion to the question whether or not it were possible to influence the development at will, and so to cause a scale leaf or a sporophyll to grow from a fundament which otherwise would develop into a foliage leaf. It has been shown that such transformations may be occasioned in a simple way, and the developmental correspondence makes such a limited transformation without further difficulty capable of being understood. And since seedlings produce, apart from the cotyledons and certain adaptations in hypogæous germination, only foliage leaves, which are arranged for the work of photosynthesis; since further it is seen that all foliage leaves of one and the same plant, different as they appear externally, yet in reality follow one and the same course of development, which, as we have seen, is remarked also in scale leaves and sporophylls; I accordingly come to the view that other leaf organs are derived from foliage leaf fundaments through a change in the course of development occurring at an earlier or later period of growth. This conception has found many opponents, some of them for the reason that they have not been able to free themselves from the purely historical conception of the problem.

But the historical question can not help us over the ontogenetic problem any more than the solution of the latter alone can answer the historical question. Even if it were proved in all cases that sporophylls, flower leaves, sepals, etc., are transformed foliage leaves, it would remain undecided that these are phylogenetically older than the former. This phylogenetic problem, however, is with our present means and knowledge not subject to solution with certainty, while the ontogenetic problem, on the contrary, is. Problems, however, which may not be solved appear to me less important than those which may.

To be sure, the solution of the ontogenetic problem is hedged about with great difficulties. For the results which have already accrued, valuable as they may be, take their importance from the fact that they lay the foundation for the future work: what changes take place during transformation, and upon what outer and inner conditions are they dependent? We may comfort ourselves as little as could Goethe at one time with the view that flowers differ from the vegetative shoot in a refinement of the sap; rather would we know what change of the materials, and what other changes, are connected with the order of successive developmental stages of the flower. This, to us as good as unacquired knowledge, should give us a more penetrating glance into the nature of development than we have as yet had. To just this purpose plants are especially well adapted, for experience has shown us that the development of a plant is not produced as is the melody in a music box, in a definite order so long as the outer source of power is present to start it; for the experiments of the last few years indicate rather 'that the form relations of chlorophyll-bearing plants are not predetermined in the germ cell, but in the course of development.'[5] As a result we can not only arrest development at any particular stage, but we can also cause fundaments to unfold which were previously 'latent.' Historical morphology has contented itself as regards the unfolding of latent fundaments also with an historical explanation of the facts. The observation, *e. g.*, that instead of the seed scale of the Abietineae under certain circumstances an axillary shoot appears, has been used by prominent botanists to support the conclusion that the seed scale has arisen phylogenetically from a shoot. Such an hypothesis would get beyond the rank of pure supposition if a living or fossil form certainly related to the Abietineæ could be pointed out, the cones of which bear in the axils of the cover scales shoots possessed of macrosporophylls. As long as such proof is not forthcoming, we stand opposed to a phylogenetic explanation of this observation 'kuehl bis ans Herz hinan.' We seek rather to establish the conditions under which the fundaments, which otherwise become seed scales, develop into shoots, and hold before us therewith the possibility that the forebears of the Abietineæ could have borne their ovules upon axillary outgrowth of the cover scales, which, indeed, possessed the ability under certain circumstances which disturbed the normal development to form shoots, but which phylogenetically does not need to have been at any time an axillary shoot.

The question of the significance of metamorphosis leads us into another field of morphology. The above-cited examples show that the transformation of organs always goes on hand in hand with a change of function. This gives us the occasion to take up a further problem of modern morphology: the relation between form and function. The old morphology believed that it should keep away from this question because it held that the function of an organ had nothing to do with its 'morphological meaning.' Just recently we

[5] Goebel, 'Flora,' 1895, p. 115.

have heard that morphology has to do with 'members' and not with the 'organs' of a plant. The fact that 'members' and 'organs' mean one and the same thing, and that for the organism their members are organs, or tools, shows that here again is a purely artificial and therefore untenable abstraction. Morphology stiffens to a dead schematism when it does not take the plant for what it really is—a living body the functions of which are carried on in intimate relation to the outside world. It was the powerful influence of Darwinism that turned more attention again to the function of single plant organs, for, according to one view, which has many adherents, all form relations arise through adaptation. D. H. Scott has given clear expression to this view in the sentence, 'all the characters which the morphologist has to compare are, or have been, adaptive.'

This is a widely disseminated conception, but is by no means as widely accepted. Above all, it must be pointed out that it is not the result of observation, but is a theory, which enjoys by no means general acquiescence. True, the conclusion drawn depends upon the meaning given to the word 'adaptive.' But take it as you will, in the Lamarckian or in the Darwinian sense, in reviewing the phenomena of adaptation we come face to face with the problem: are the form characters fixed adaptational characters solely, or have we to distinguish between organization and adaptational characters? There are several grounds which have led to the belief that organization and adaptational characters coincide. Chiefly the brilliant results which investigation concerning the functional significance of structures as well in the flower as in the vegetation organs has had in the last decade. It was evident that structures to which were earlier ascribed no sort of function yet have such. And if none was found, there yet remained the possibility that the structures concerned had earlier been useful as adaptations. It is, however, clear that we are hereby near to the danger of accepting something as proved which needs rather to be proved. In reality, it seems to me that morphological comparison as well as experiment shows that the distinction between organization and adaptational characters is justified, and that the opinion to which Scott has given expression has arisen from the admission that specific characters have arisen through the accumulation of useful fluctuating variations effected by the survival of the fittest. But we see that in many cases specific characters are not adaptive. If we follow out, *e. g.*, the systematic arrangement of the Liliifloræ, we see that the particular groups differ from each other as to whether the ovary is inferior or superior, and whether it later becomes a capsule or a berry, and, if it is a capsule, whether it is loculicidal or septicidal. Concerning these characters one may well ask whether one can bring the berry or the capsule into relation with the question of adaptation; whether it can be shown that the berry-bearing Liliifloræ occur or have arisen chiefly in those regions where also occur many birds which devour the berries and thus disseminate the seeds. Such a relation can not at present be shown to exist. And who would regard the question whether a capsule opens septicidally, as in the Colchicaceæ, or loculicidally as in the Liliaceæ, as one which stands in relation to adaptation? The method of opening is conditioned by the structure of the fruit in the Colchicaceæ and Liliaceæ, but for the scattering of the seed it is evidently quite a matter of indifference. Shall we conclude that in the past it was otherwise?

Here again we are shown that we get along the best when we start out with the observation of the plants which surround

us, and not with theoretical assumptions and far-reaching phylogenetic hypotheses. The theory of mutations formulated by de Vries with such brilliant results is the result of this kind of patient and step-by-step observation of the now living plant world. The observations of de Vries show us that specific characters arise not through the accumulation of useful variations, but by leaps, and have nothing at all to do with direct adaptation. Such as are disadvantageous in the struggle for existence are weeded out. But selection can not effect the origin of specific or organization characters as such, and this makes it clear to us why—from the human standpoint—one and the same problem may be solved in such different fashions.

The mutation theory of de Vries limits itself to that alone which the observation of the present moment can come at, to the origin of the so-called 'minor species.' But how the division of the plant kingdom into the larger groups has come about, how it has happened that the 'archetypes' have reached such marked development and others have died out or remained in abeyance, are further problems, the solution of which may not so soon be looked for. For this, however, the more intimate knowledge of the factors which regulate the development of the individual from the egg cell to the ripening of the fruit, forms a fundamental starting point. For this purpose plants are especially suitable, since, on the one hand, because of the possession of a *punctum vegetationis*, they are in later life also provided with embryonal tissue, and, on the other hand, because in their form they are more exposed to the influence of the outside world than the majority of animals.

An especially important means in order to the causal study of development has the research into those phenomena proved itself, which we designate the regeneration of new formations as the result of wounding. The questions: what really takes place when an embryonic cell becomes a permanent cell; the reciprocal influences of separate plant organs, which we call correlation; further the problem of polarity; stand out with great clearness in the phenomena of regeneration. I can, however, at this moment only indicate the problems, and can not point out the steps which have been taken toward their solution. A wide vista spreads out before us. The more must we wonder that of the countless botanical papers which appear each year not more than perhaps a dozen are concerned with the problem of development.

Summing up this brief presentation, it should have been shown that morphology, which originally formed a part of taxonomy, then grew apart from it as an independent discipline. Only when it gives up this separate position will morphology take on new life, for such a position is warranted only historically and not in the facts.

The earlier morphologists would have said that morphology has as little to do with the physiology as with the anatomy of plants, which latter, at the time when systematic botany was in the ascendant, they reckoned also as physiology. For physiology was then everything which was not taxonomy. Nowadays it would be carrying coals to Newcastle to point out the significance of the cell doctrine for morphology. For the understanding of alternation of generations, of inheritance and other phenomena fundamentally important to morphology the doctrine of the cell has become of basic significance. The same is true in a higher degree for the relation between morphology and physiology, for all other tasks of the descriptive natural sciences are, after all, only preliminary attempts at orientation, which at length lead

to experimental questioning, to physiology. Indeed, one may say that morphology is that which is not yet understood physiologically. The separation of the different tasks of botany is not in the nature of things proper, but is only a preliminary means at first to orientate ourselves with reference to the maze of phenomena. The barriers between these tasks must then in the nature of the case fall with further progress. I do not wish to deny the value of phylogenetic investigation, but the results which it has brought forth resemble more the product of creative poetic imagination than that of exact study, *i. e.*, study capable of proof. If the knowledge of the historical development of plant forms hovers before us as an ideal, we shall approach it only when we attack the old problems of morphology, not simply with the old method, that of comparison, but experimentally, and when we regard as the basal problem of morphology not phylogenetic development, but the essence of development in a large sense. Even if we had the story of development spread out clearly before us, we could not content ourselves with the simple determination of the same; for then we should be constrained to ask ourselves, how it has been brought about. But this question brings us straight back to the present, to the problem of individual development. For there is for natural science hardly a more significant word than this of Goethe's: 'was nicht mehr entsteht, können wir uns als entstehend nicht denken. Das Entstandene begreifen wir nicht.' It is then the task of modern morphology to learn more exactly the factors upon which at this time the origin of structures depends. To this task, for which there was at that time but little preparatory work consisting of a few important attempts by the gifted Thomas Knight, Wilhelm Hofmeister, who is known to most of us only as a comparative morphologist, did a too little recognized service. For he pointed out, even before this trend of study became apparent in zoology, that the ill-designated 'Entwickelungsmechanik' pursues essentially the same goal as the causal morphology of botany.

We may regard as a motto this sentence from Hofmeister's 'allgemeiner Morphologie': 'es ist ein Bedürfnis des menschlichen Geistes, eine Vorstellung sich zu bilden über die Bedingungen der Formgestaltung wachsender Organismen im allgemeinen.' This is even now the problem of present day morphology. Comparative consideration, including, of course, the especially important history of development, offers us valuable preparation for the intellectual grasp of the problem, but, above all, for the pursuit of the experimental method.

That the zoologists also have felt this necessity to strike out into new ways besides that of comparative morphological observation shows anew that for all organisms the problems are really the same. Let us then take for our watchword development, not only as a problem, but also for the methods with which we seek to bring ourselves nearer its solution.

SCIENTIFIC BOOKS.

Research Methods in Ecology. By FREDERIC E. CLEMENTS, Ph.D. Lincoln, Nebraska, The University Publishing Company. 1905. Pp. xvii + 334.

This work by Professor Clements is intended by the author as a handbook for investigators and for advanced students of ecology, and not as a text-book of the subject. It, therefore, contains a somewhat elaborate account of methods used by the author in his studies of the last eight years during which a serious attempt has been made by him to discover and to correlate the fundamental points of view in the vast field of vegetation.

The book is presented in four chapters or

parts, the first of which deals with the scope, historical development, present status and important applications of ecology. Under the latter caption its connection with physiology and pathology, experimental evolution, taxonomy, forestry physiography, soil physics, zoogeography and sociology is pointed out. The second chapter is concerned with the habitat and methods of its investigation. First, the factors are determined and classified and then an account is given of the various instruments, including geotomes, psychrometers, psychrographs, photometers, selagraphs, thermometers, clinometers, trechometers, etc., which are employed in the study of the habitat, together with methods of charting statistics. By these instruments and methods statistical analysis of soil water content, humidity, light, temperature, precipitation, wind, soil structure and chemistry, altitude, slope, exposure, etc., is made possible. There is attention paid to the details of choosing instruments, stations and readings. The plotting of curves and determination of graphic representations is explained. The third chapter has to do with the plant, the stimuli which it receives, the nature of its response, its adjustment and adaptation especially to water and light as stimuli. Here some experimental evolutional methods are set forth having to do with the selection of species, the determination of factors and the recording of habitat cultures and control cultures. The fourth chapter, which is the most extensive and to which the other three are in a sense preliminary, has for its general subject the formation or vegetation unit consisting essentially of plants in a habitat, the need for exact investigation of which is set forth by the author. Quadrats, transects, migration circles, are described and their use explained. The two important arts of cartography and photography in their relation to ecologic inquiry are given space, and methods of preparing and preserving formation and succession herbaria are indicated. The development and structure of vegetation are taken up under the conception that the formation is a complex organism which possesses functions and structure and passes through a cycle of development similar to that of the plant. The functions of a formation are described as association, invasion and succession, while its structure may comprise zones, layers, consocies, societies, etc., all of which may be referred to zonation or alternation. Thus classified, the facts and laws of migration, dissemination, barriers and indemism, polygenesis, etc., are given detailed discussion. The final pages are devoted to experimental vegetation with description of culture methods for formational aggregates.

Throughout the volume Professor Clements makes use of his carefully devised nomenclatural system, the extent of which is very considerable. A great many thousand new words and nomenclatural combinations are proposed, for the most part derivatives from the Greek. This system has already been brought to the attention of ecologists in papers in Engler's 'Jahrbücher' (1902) and elsewhere and has attracted attention. A glossary of ten pages in which the more fundamental new words are gathered is a helpful addition to the work. An index is not provided, but the glossary to some extent fills its place.

Eighty-five illustrations, for the most part half-tones, of vegetation, plants and apparatus serve to lighten up the text. Most of these are original views of Colorado vegetation prepared by the author and give a very excellent idea of the grouping of plants upon some of the mountain habitats.

Altogether, Clements's 'Research Methods in Ecology' is a notable contribution to the literature of ecology and the author is to be congratulated upon its successful delivery to the botanical world. CONWAY MACMILLAN.

The Becquerel Rays and the Properties of Radium. By Hon. R. J. STRUTT. London, Edward Arnold. 1904.

One closes Mr. Strutt's book with a feeling of rare satisfaction. The reader has had a clear and concise presentation of the fundamental phenomena of the Becquerel rays, and the phenomena centering around that astonishing substance, radium.

The book, which lays no claim to an exhaustive treatment of the subject, is primarily written for those who wish to know something about radioactivity and are interested in sci-

ence. Abstruse ideas are left out just so far as possible, and the work, although not phrased in popular language, as we understand the term to-day, is nevertheless very clearly and readably written. Mr. Strutt has evidently the faculty of presenting scientific facts in a very pleasing and attractive and convincing form. In short, he shows the stamp of the teacher.

Notwithstanding all the evident care of preparation in the work, Mr. Strutt has once or twice allowed himself to become careless in the use of terms. For example, on page 66, when treating the selfelectrification of radium, he uses the term 'perpetual motion,' stating that the above phenomena more clearly approach it than any other action we are acquainted with. It seems to me that the term is very wrongly applied, because perpetual motion means the performance of work without the expenditure of energy; and there certainly is energy expended in the above phenomena. Later on in the book (page 167) he states that 'Nothing that we can do to any portion of matter will in the smallest degree affect its weight,' etc. This is rather too loose a statement to let pass without comment.

Chapter I. discusses some general statements about the discharge of electricity through gases, a subject that Dr. J. J. Thomson has so thoroughly investigated. The discussion of the cathode and Roentgen rays contains descriptions of the various phenomena connected with them.

Chapter II. deals with the discovery of radioactivity, the first portion treating of the signal work of Becquerel, who discovered the rays which bear his name, namely, those rays which are given off by some salts, and which have photographic properties, but which differ from Roentgen rays and also from ordinary light.

The discussion of the various phenomena relative to uranium prepares the reader for the story of the discovery of radium. Mr. Strutt explains in an interesting and instructive manner the chemical procedure gone through to make it possible to obtain radium from pitchblende, a mineral in which was discovered by Madame Curie a radioactivity far in excess of what was expected. This fact led Madame Curie to conclude that there resided in the mineral some other more active constituent than uranium.

In Chapter III. we have the properties and nature of the radiations described together with the fluorescent, chemical and physiological effects. This is followed by a rather complete discussion of the alpha rays, beta rays and gamma rays, with several diagrams illustrating experiments carried out to determine the deflection of the alpha rays and beta rays. The experiments with gamma rays have so far been negative.

At considerable length in one of the chapters is described the subject of radioactvity in the earth and its atmosphere, a branch of the work to which Mr. Strutt has contributed rather extensively. Other chapters treat of absorption and ionization; changes occurring in radioactive bodies; the products of radioactive change.

The last chapter gives a short account of the electrical theory of matter, to which Professor J. J. Thomson has given much thought. This chapter is very suggestive and supplies food for contemplation.

At the end of the book there are three appendices, the first of which contains a number of experiments which any one may perform with a bit of radium. A sufficient amount of radium necessary for these experiments would cost in the neighborhood of twenty-five dollars. With this appendix are given two plates.

The other two appendices treat respectively of the mathematical theory of the deflection of the beta rays; a short account of the extraction of radium from large quantities of pitchblende.

The book is non-mathematical throughout, except for the appendix mentioned, and shows a keen insight into the subject dealt with. This, however, is to be expected from a man who has done so much work in the realm of radioactivity. On the whole, the book is to be commended to those who are of a scientific turn of mind, and who wish to understand clearly the principal phenomena of radioactivity.

G. B. OBEAR.

PROVIDENCE, May 24, 1905.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *American Journal of Science* for July contains the following articles:

D. A. KREIDER: 'Iodine Titration Voltameter.'

F. A. GOOCH: 'Handling of Precipitates for Solution and Reprecipitation.'

R. H. ASHLEY: 'Estimation of Sulphites by Iodine.'

M. TALBOT: 'Revision of the New York Helderbergian Crinoids.'

L. V. PIRSSON: 'Petrographic Province of Central Montana.'

T. HOLM: 'Croomia pauciflora.'

E. RUTHERFORD and B. B. BOLTWOOD: 'Relative Proportion of Radium and Uranium in Radioactive Minerals.'

J. TROWBRIDGE: 'Side Discharge of Electricity.'

H. L. BRONSON: 'Effect of High Temperatures on the Rate of Decay of the Active Deposit from Radium.'

THE contents of the June issue, *Terrestrial Magnetism and Atmospheric Electricity,* are as follows:

Frontispiece: Portrait of Karl Selim Lemström.

H. GERDIEN: 'Die Absolute Messung der specifischen Leitfähigkeit und der Dichte des verticalen Leitungsstromes in der Atmosphäre.'

J. DE MOIDREY, S.J.: 'Mesures magnétiques en Chine.'

H. F. REID: 'Records of Seismographs in North America and the Hawaiian Islands.'

HJ. TALLQUIST: 'Karl Selim Lemström, His Life and Work.'

E. BIESE: 'Verzeichniss der Publicationen des verstorbenen Professors Selim Lemström.'

Letters to Editor—L. A. BAUER: 'Work of the Department of Terrestrial Magnetism of the Carnegie Institution for 1905.' W. F. WALLIS: 'Principal Magnetic Disturbances Recorded at Cheltenham Magnetic Observatory, March 1 to May 31, 1905.'

Notes—'Additional Eclipse (August 30, 1905) Stations.' 'Miscellaneous.'

SOCIETIES AND ACADEMIES.

THE MISSOURI SOCIETY OF TEACHERS OF MATHEMATICS.

THE past few years has been a very widespread movement among teachers of mathematics towards the organization of local, state and sectional associations of teachers of mathematics. This movement is both a result and a cause of a very general dissatisfaction with methods of teaching mathematics in the recent past, and of various kinds of attempts to improve them. Among the many ideas that are prominently discussed are those suggested by the terms correlation, laboratory methods, individual instruction, self-activity, graphical methods, etc. The facts of modern life are furnishing material which is replacing obsolete problems. An effort is being made to bring mathematics into vital relations with the whole of life. Even the long undisturbed supremacy of the methods of Euclid in secondary education is being questioned. What will it lead to? Even the elementary teacher can not fail to see what the investigator has never lost sight of, that he is dealing not with a completed, a dead, a petrified subject, but with one of the most vigorous, living, growing subjects taught in our schools. Perhaps one of the strongest evidences that this is the case is seen in the large number of state and sectional organizations of teachers of mathematics throughout the country.

The first annual meeting of the Missouri Society of Teachers of Mathematics met at Columbia, Missouri, May 6, 1905. A preliminary meeting had been held at St. Louis in connection with the National Educational Association. The temporary organization of the society was effected at the meeting of the State Teachers' Association at Columbia, December 28, 1904. At a meeting of the mathematics section of that body a committee of organization was appointed, consisting of E. R. Hedrick, University of Missouri, Columbia; H. C. Harvey, State Normal School, Kirksville, and B. T. Chace, Manual Training High School, Kansas City.

The permanent organization was completed at the meeting on May 6. The constitution provides that there shall be at least two meetings each year, one in connection with the annual meeting of the State Teachers' Association, the next meeting of which will be held at Jefferson City, December 1905, and one during the month of April or May, which shall be the annual meeting for the election of officers and the transaction of general busi-

ness. The general management of the society is in the hands of an executive council of six members. Steps have already been taken towards the establishment of several divisions.

The total membership of the society is two hundred and thirty-six.

L. D. Ames, of Columbia, presided at the meeting. The following officers were elected:

President—H. C. Harvey, Kirksville.

Vice-President—L. M. Defoe, Columbia.

Secretary—L. D. Ames, Columbia.

Executive Council—E. R. Hedrick, Columbia (chairman); B. T. Chace, Kansas City; B. F. Finkel, Springfield; B. F. Johnston, Cape Girardeau; Wm. Schuyler, St. Louis; Miss E. J. Webster, Kansas City.

The monthly journal, *School Science and Mathematics,* was made the official organ of the society, and will be sent free to all members. The annual dues are one dollar and fifty cents.

Arrangements were made to send delegates to a conference to be held in connection with the National Educational Association, which met at Asbury Park, N. J., on July 7–11, 1905, looking towards the organization of a national society.

The following papers were read:

E. Y. BURTON, St. Charles Military Academy: 'Correlation of Arithmetic, Algebra, Geometry and Trigonometry.'

WM. SCHUYLER, McKinley High School, St. Louis: 'An Experiment in Individual Instruction.'

GEO. R. DEAN, School of Mines, Rolla: 'A Method of Teaching Elementary Geometry.'

J. W. WITHERS, Yeatman High School, St. Louis: 'The Teaching of Mathematics in the High School.'

F. C. TOUTON, Central High School, Kansas City: 'Some Developments in Elementary Algebra.'

WM. A. LUBY, Central High School, Kansas City: 'The Teaching of Zero and Infinity in the High School.'

Abstracts of these papers will be published in *School Science and Mathematics.*

L. D. AMES.

THE TORREY BOTANICAL CLUB.

THE meeting of May 9 was held at the New York Botanical Garden, with President Rusby in the chair and 42 members and visitors present.

The meeting was devoted to the exhibition and discussion of the various forms of American violets. The discussion was opened by Dr. N. L. Britton, who spoke of the recent specific differentiations of various authors. He was of the opinion that many of these were doubtful and that while we had, perhaps, twice as many good species as were known in Gray's time, we only have about half as many good species as have been described. The speaker then gave a general sketch of the group, noting that while they are preeminently a north temperate cosmopolitan group they extended into the southern hemisphere along the highlands in both the orient and the occident. There is only a single endemic and one introduced species known from the West Indies. Mexico furnishes, perhaps, half a dozen species, and there are numerous species in the highlands of South America. Our violets fall naturally into two habit groups, the acaulescent and the stemmed. A rather common character is the occurrence of cleistogamic flowers, which are borne on horizontal or erect scapes according to the species. The speaker passed the various species in review, paying particular attention to those of eastern North America.

Stewardson Brown, of the Philadelphia Botanical Club, was called upon to review Dr. Britton's remarks. He said that in the main he agreed with Dr. Britton's views of specific validity. He called attention to a form from the vicinity of Philadelphia which Stone recently identified as *Viola septemloba* of LeConte of the *palmata* group, and which the speaker believed to be something different. Attention was also called to *Viola obliqua,* one of the earliest and most abundant violets in the Philadelphia region. The speaker described the *sagittata-fimbriatula* group as one of the most integrated and little understood of any of the groups of acaulescent blue violets.

Continuing the discussion, W. W. Eggleston mentioned the occurrence of what he believed to be a hybrid form. He also called attention to President Brainerd's methods of studying violets under cultivation and observing their fruit characters.

L. H. Lighthipe called attention to *Viola*

Angelli, holding it to be distinct from *Viola palmata*, the differences showing in the character of the flowers and of the summer leaves. Miss Angell, who was present, told of her studies of this species and called attention to the extraordinary size of the summer leaves. Dr. Rusby in the course of his remarks mentioned a very early form which is apparently the variety *cordata* of *Viola cucullata* of Gray. This form has been studied extensively by Miss Sanial, one of the club members.

Dr. Rydberg spoke of the violets of the Rocky Mountain region, passing in review the various species from that section and calling attention to the occurrence of the common European *Viola biflora* which reappears in Colorado.

Dr. Shull spoke of the difficulty he had experienced in germinating violet seeds, and in the discussion it was brought out that violet seeds are apt to lose their vitality upon drying.

Dr. MacDougal spoke of the difficulties attendant upon mutation experiments with the violets, and advocated experiments to test any possible theories as to hybrids.

After some further discussion by Dr. Britton and others this most interesting meeting was brought to a close.

EDWARD W. BERRY,
Secretary.

THE UNIVERSITY OF COLORADO SCIENTIFIC SOCIETY.

DURING the academic year 1904–5 the society met every Monday evening from October to May, holding in all thirty meetings. In nearly all cases a single topic was discussed at each session, but a few times there were two papers given. The speakers avoided technicalites as far as possible and presented their topics in such form as to be interesting to men of science generally. Papers were given, for the most part, by members of the faculty representing the various departments of pure and applied science. At the last meeting of the year, held on May 15, the following officers were elected:

President—Henry B. Dates.
Vice-President—Ira M. DeLong.
Secretary—Francis Ramaley.
Treasurer—Martin E. Miles.

FRANCIS RAMALEY,
Secretary.

BOULDER, COLO.,
June 7, 1905.

SPECIAL ARTICLES.

NEW WORK UPON WHEAT RUST.

FOR a number of years it has been the belief of the writer that the efficiency of the uredospores (summer spores) of wheat rust to perpetuate the disease is possibly much greater than thought to be. It has been assumed by most botanists that these spores are quick to germinate and short of life. As there are formed definite resting spores, and also the cluster cup stage on the barberry bush, it has been apparently taken for granted that the summer spores have no other effect than to rapidly spread the disease from plant to plant during the summer season.

It will be interesting news to mycologists to know that we have at last definitely established the fact of the wintering of the red spores (uredospores) of a number of the important rusts in viable form, including the important species *Puccinia graminis*.

During the winter of 1888 and 1889 the writer, while working at the Indiana Station, first demonstrated the fact that the mycelium of the uredo stage (red spore stage) of the species known as *Puccinia rubigo-vera* could pass the winter in the tissues of the wheat plant uninjured (see *Agricultural Science*, Vol. 3, page 105). During the summer of 1890 (see *Agricultural Science*, Vol. 5, Nos. 11 and 12) it was further proved that the red spores of this last-named species could survive exposure to the drying air and sunshine of July and August for over a month. This indicated that it was possible for such spores to be borne many miles by the wind, and aided to an understanding of the rapidity with which general rust infection may take place over large areas of country.

Aided by the persistent and painstaking efforts of assistant plant pathologist Mr. F. J. Pritchard, I have at last been able to make numerous trial studies upon methods of stor-

ing and keeping wheat and other types of grass straw, which is infected by red rust, so as to carry out various studies upon the most successful methods of testing the vitality of the spores from week to week and from month to month. We are now able to announce definitely that the vitality of the red spores (*uredospores*) of *Puccinia graminis*, in certain cases, may remain unimpaired by the action of the drying winds of autumn and the intense cold of a North Dakota winter. In some cases we have been able to germinate as high as eighty to ninety per cent. of all the spores under test. We have found these spores successfully surviving upon dead leaves, dead straw and upon the partially dead or green leaves of living grain or grasses. This applies also to a number of other important rusts which attack wheat and allied grasses.

In the case of *Puccinia rubigo-vera*, the smaller wheat rust, it has been found by the writer to be wintering freely in Mississippi, Texas, Illinois, Minnesota and North Dakota both upon living leaves of wheat or winter rye and upon the matured leaves and straw of the same. This fact will of necessity have great weight upon the future investigations of wheat rust. The matter of the barberry stage and other æcidial rusts may yet be proved to be of physiological necessity for the perpetuation of the species, but it would seem that these need no longer be believed to be a direct yearly necessity to the perpetuation of the rusts concerned.

HENRY L. BOLLEY.
NORTH DAKOTA AGRICULTURAL COLLEGE.

CONCERNING THE IDENTITY OF THE FUNGI CAUSING AN ANTHRACNOSE OF THE SWEET-PEA AND THE BITTER-ROT OF THE APPLE.

ABOUT a year ago I received some sweet-pea stems from Inwood, W. Va., with a request as to the cause of the plants dying. These stems had dead, shrunken areas on them with masses of pink spores scattered about over the dead areas. There were also a few spore masses on some of the leaves. An examination showed that the dead areas were probably caused by some species of *Glœosporium*, but no such fungus has been found as occurring on the sweet-pea in the literature that I have had access to. I have called the disease an anthracnose on account of its resemblance to the anthracnoses of some other plants.

More material was secured at different times during the autumn, and it was my intention to make a personal investigation of the disease until after Mr. A. Lee Post became officially connected with the experiment station and a student in the university, when the problem was assigned to him under my direction. He began a study of the life history of the fungus by means of artificial cultures and inoculations. The results of the investigation, up to date, have been presented in the form of a thesis, and will probably be published later with slight alteration and the addition of new data.

While examining some of the agar cultures with Mr. Post, I noticed that there was an occasional cell of the mycelium that contained spores, the number of spores in the cells varying. To all appearances the endospores were the same as those borne externally on the hyphæ. This was the first time that I had seen endospores in the mycelium of a fungus other than those found in bacteria, and correspondence with some of the leading mycologists has failed to give me any definite light on the subject of endospore formation in the higher fungi.

The manner of growth of the mycelium and the way the conidia were produced were so characteristic of the bitter-rot fungus of the apple and the one causing the mummy disease of the guava, that Mr. Post made some inoculations in apple-agar and in apples. The result of the inoculations on apples was so similar to the bitter-rot of the apple that a number of mycologists have pronounced it genuine bitter-rot.

Through correspondence with the person who sent me the diseased sweet-pea stems, I learned that the sweet-peas grew near an apple tree, the fruit of which rotted. Just what kind of a rot it was will be determined this fall if possible. This rotting of the apples on the tree near the sweet-peas, suggested the possible identity of the anthracnose of the sweet-pea and bitter-rot of the apple. To prove

whether they are, or are not, the same, I let Mr. Post have some specimens of bitter-rot and of the ripe-rot of the grape collected at least two hundred miles from where the sweet-peas grew. Seedling sweet-peas, inoculated with spores from these two sources, were killed at the point of infection in the same way that the original sweet-pea stems were killed, and other seedlings which were inoculated with pure cultures of the fungus causing the anthracnose of the sweet-pea.

It would seem, then, from the results obtained, as if the bitter-rot of the apple, the ripe-rot of the grape and the anthracnose of the sweet-pea are caused by the same fungus. A stage corresponding to the ascigerous stage of the bitter-rot has not been obtained yet in artificial cultures.

John L. Sheldon.
West Virginia Agricultural Experiment Station, Morgantown, W. Va.,
June 19, 1905.

INDICATIONS OF AN ENTOMOPHILOUS HABIT IN TERTIARY SPECIES OF QUERCUS.

The occasional development of several embryos in the fruits of recent species of *Quercus* is of interest as suggesting an entomophilous habit in the flowers of the Tertiary species of this genus.

At present normally five of the six ovules in the three-celled ovary atrophy, and the one remaining forms later a perfect embryo which fills the entire cavity of the nut. But it not infrequently happens that two embryos develop, each with cotyledons, plumule and caulicle. Experiments made by the writer show that both embryos will grow, and the twin oaks were kept until they reached a foot or more in height. Several cases were found by the writer in which three perfect embryos occurred in acorns of the chestnut oak, *Quercus prinus*. All germinated nearly equally well. Finally a single case was found in which there were four perfect embryos. This also was an acorn of the chestnut oak, which develops several embryos more readily than *Q. alba, rubra* or *tinctoria*.

[1] Several notes have been previously published on the development of two embryos in *Quercus*, but I have not found any record of three or of four perfect embryos occurring in this genus.

The normal abortion of five ovules and reduction to one embryo seems to be an acquired character, and in the development of several embryos appears to be a reversion to an ancestral condition.

Now, it is well known that the formation of several or many embryos is characteristic of entomophilous flowers, but very rare among anemophilous.

This suggests that the oaks of the Greenland Tertiary flora were entomophilous, that their flowers were more conspicuous, and that their fruits normally developed several embryos. With the oncoming of the ice sheet the oaks moved very slowly southward because of the inadaptability of the fruit for wide dispersal. Deserted by the insects seeking the warmth farther south, the oaks may then have adopted their present anemophilous habit.

Paleobotany so far can give no evidence either for or against this theory, but later studies of the Tertiary floras may strengthen the indication now furnished by the development of two, three and four embryos in cases of reversion in *Quercus prinus*.

C. J. Maury.

BATHYGNATHUS BOREALIS, LEIDY, AND THE PERMIAN OF PRINCE EDWARDS ISLAND.

A few days ago I had occasion to examine the figure of *Bathygnathus* published by Leidy in his original description (*Jour. Acad. Nat. Sc. Phila.* (2), 11, pp. 327–330, pl. XXXIII.) and became convinced that it was not a dinosaur, as has been long supposed, but one of the most specialized of the pelycosaurs, such as occurs in the Texas region, probably a *Dimetrodon* or *Naosaurus*. I communicated with Dr. Lambe, of the Canadian Survey, indicating my belief that this settled the question of the possible occurrence of Triassic deposits in Prince Edwards Island. Almost all of the geologists of the Canadian Survey who have worked on the island have considered the rocks as Permo-carboniferous and have

admitted the possibility of Triassic rocks in the neighborhood of New London only because *Bathygnathus* was found there and was considered as a Triassic dinosaur. Hardly had the letter been posted when I received from Dr. von Huehne his paper on the 'Pelycosaurier im Deutschen Muschelkalk' (*N. Jahrb. f. M. G. u. P. Beilage,* Band XX., p. 343), in which he arrives at exactly the same conclusion as to the nature of the fossil and the age of the beds. Aside from settling the age of the beds of Prince Edwards Island the discovery is of interest in extending the range of these forms which have previously been known from Texas, Vermillion County, Ill., and Bohemia. It is interesting also to note, as pointed out by von Huehne, that Owen in the *Q. J. G. S.,* 1876, pointed out that *Bathygnathus* was probably related to the theriodonts. This suggestion has been disregarded in favor of the dinosaurian nature of the fossil and has so kept alive the error in the age of the beds.

E. C. CASE.

A SYSTEM FOR FILING PAMPHLETS.

No system for filing pamphlets will meet the requirements of all workers, but a plan that I have used for some years has proved so satisfactory and met with the approval of so many of my friends that I venture to present a brief outline of it, in order that others may perhaps be benefited. I make no claim for originality except, perhaps, in the size of the boxes.

I use pasteboard boxes very much like those used by the Book Lovers' Library to protect its volumes, ten and one half inches high, seven and one fourth inches deep and one inch thick, the back or edge nearest the wall, as they stand on the shelf, being open.* Each box holds only a small number of pamphlets, and therein lies the chief advantage, as the small boxes facilitate a great subdivision of subjects.

In my series of 'Birds, geographic,' for instance, I have a box for faunal papers for every state in the United States and for some states several boxes, the subdivision in these cases being by authors. Every faunal bird paper is marked in the corner 'Bg,' followed by a number indicating a country, the United States being, for instance, 4, with each state designated by a decimal number, so that a Pennsylvania faunal bird list would be marked 'Bg 4.9,' the Pennsylvania box bears this label on the back and also one inscribed 'Birds of Pennsylvania.'

I have then a card catalogue of all my separata, etc., arranged by authors with a reference to the box number. It is thus possible to take from the shelf at once all the papers relative to a given subject or by the card list to locate any paper that may not be where I expected to find it or to see if I have a paper by a certain author.

In the case of a composite paper it may be arranged where most frequently sought and a cross reference be entered on a stiff sheet of octavo paper placed in the other box where it might be arranged. In fact, a sheet like this in every box with cross reference titles is of great convenience.

Bound volumes may be arranged in their proper place on the shelves and catalogued just like the pamphlets.

This system permits of endless variations in the method of classification. For my ornithological series I have the following divisions:

Ba, anatomy; Bb, bibliography; c, classification; d, destruction and extinction; e, economic ornithology; f, food; g, geographic lists; h, hybrid, albinos, etc.; l, museum catalogues; m, molt and pterylography; n, migration; o, nests and eggs; s, systematic monographs, etc.; v, song. Bg and Bs are, of course, the large series, the others occupying only two or three boxes each.

The arrangement of pamphlets relating to so broad a subject as ornithology, by authors, is almost useless, as it is impossible to remember all who have written, for instance, on the birds of Pennsylvania. My plan gives you all these papers together on the shelf without consulting the card list, while if the arrangement by authors is needed the cards furnish it.

WITMER STONE.

ACADEMY NATURAL SCIENCES,
PHILADELPHIA.

* Made by Jesse Jones Paper Box Co., 715 Commerce St., Philadelphia, at $3.50 per hundred.

CURRENT NOTES ON METEOROLOGY.

BAROMETER AND WEATHER.

Under the title 'Barometer und Wetter,' van Bebber discusses, in the *Archiv der Deutschen Seewarte* (Vol. XXVII., 1904, No. 2, pp. 1–15), the use of the barometer as a 'weather glass,' for foretelling changes of weather; refers to the studies already made to determine the barometer readings which correspond to certain weather conditions, and then investigates the relation between the readings at Hamburg and the rainfall, temperature and cloudiness, for the year, seasons and individual months during the period 1876–1900. It appears that rain falls very infrequently when the barometer is very high; that it is then extremely light, and comes only in the colder months. Rain probability shows a steady increase with decreasing pressure; at extremely high pressures (over 30.50 ins.) there is no precipitation, and at pressures below about 28.90 ins. there is always precipitation. As to temperatures, the departures are negative at the higher pressures and positive at the lower, when averaged for the year. At low pressures the departures are positive in winter and negative in summer. Cloudiness is at a minimum during highest barometric pressure, and at a maximum during low pressure. In winter, however, high pressures are usually accompanied by fog. In Central Europe most of the precipitation of the colder months comes with falling, and of the warmer months with rising pressure, while in the British Isles and over the North Sea area it comes with falling pressure in all seasons. The critical study of these relations of pressure and weather conditions, which are set forth numerically in his paper, leads van Bebber to the conclusion that a reasonably accurate judgment of existing and coming weather can be based on the readings of the barometer, especially when the location of the cyclonic and anti-cyclonic centers can be learned from the newspaper reports. The last paragraph in the article is a quotation from a publication by the same author, dated 1899, to this effect: An experience of twenty-five years has brought Dr. van Bebber to the conclusion that no reorganization of weather service work would be of any value if the present forecasts for a single day following are adhered to. These forecasts have not satisfied the agricultural interests and will not satisfy them in the future. Nor will the forecasts be satisfactory unless the general public understands better than at present the basis on which weather predictions rest.

Dr. van Bebber's work along the line of public education in weather types, and what these types means has been a most valuable one, and the present investigation, which might well be carried on for any number of American stations, is a useful extension of his previous studies.

MONTHLY WEATHER REVIEW: ANNUAL SUMMARY, 1904.

The value of back numbers of the *Monthly Weather Review* has in the past been very much decreased by the fact that an adequate index has not been prepared for each volume. The index hitherto published has been an author index, arranged alphabetically so far as the authors' names were concerned, but not arranged alphabetically so far as the titles of the papers were concerned. The result has been a large and wholly unnecessary expenditure of time in looking up some special article or note. For the year 1904, we are glad to see, there is a fairly adequate author and subject index, arranged alphabetically as a whole, although the separate articles under different subject-headings are not in all cases alphabetically arranged. Thus, for example, to take only one case, under 'Observatories' we find the following:

At Mount Tsukuba	463
At Nice	182
The results of the work done at Tegel	555
Helwan and Abbassia observatories	374
New astrophysical and meteorological	130
New mountain	131
Mount Weather Meteorological Research Observatory	601

The 1904 index is so great an improvement on the old one that we can not help hoping that the 1905 index will be still better. All those who use the *Review* will be grateful for the work of Mr. George A. Loveland, who pre-

pared the index for 1904, and will hope that he may have time next year to make a more complete index for the 1905 volume.

CLIMATE OF JERUSALEM.

Professor G. Arvanitakis, in the *Bulletin de l'Institut Égyptien* (4th ser., No. 49), has published a series of meteorological observations taken at Jerusalem, as well as some notes on the climate of that region. The winds from the east are extremely dry, coming as they do from the Arabian deserts. Rain comes from the western quadrants. Hail is noted as being fairly common in Palestine, and a source of injury to the fruits. The observer says that he seldom saw a heavy rainfall unaccompanied by hail. Cisterns and reservoirs supply water during the dry season of summer, and the heavy dews are very beneficial to vegetation. These dews are characteristic of Palestine, and must be seen to be fully appreciated. The climate is not described as very healthful. Dysentery, fever and rheumatism are not uncommon at Jerusalem, especially during the summer months.

MARINE METEOROLOGICAL SERVICE OF CHILE.

The meteorological work carried on at the coast stations of Chile, from Arica in the north to the Strait of Magellan in the south, is under the direction of the so-called 'Direccion del Territorio Maritimo' of Chile. Up to the year 1899 this work was in charge of the central observatory at Santiago. An annual volume (*Anuario*) is issued, giving complete tabulations of the data for each of the eighteen stations, and including monthly and annual summaries. Thus far (1903, Vol. V., issued 1904) no discussion of these observations has been included. These littoral stations of Chile have the great advantage of varying but little in their longitude, and of being very near sea level, so that there is much uniformity in these respects. The great climatic interest of Chile, which results from its peculiar position with reference to the Cordillera of South America, and from its extraordinary contrasts in rainfall between the arid north and the rainy south, lends exceptional value to any such data as those included in the volumes here considered.

R. DeC. Ward.

NOTES ON FORESTRY.

WHY PRAIRIES ARE TREELESS.

In a paper by Alfred Gaskill read before The Society of American Foresters, February 23, the theory that forest fires are responsible for the treeless condition of the prairies was advocated. In support of this by no means new theory, Mr. Gaskill cited some geological, physiographical, climatological and silvical facts which, in his opinion, point most emphatically to the fire origin of all true prairies. He divides the treeless area in the United States into plains and prairie. The former are treeless, primarily because of deficient moisture, and were so from time immemorial. It is different, however, with the prairies; they offer conditions favorable to tree growth and, therefore, their treeless condition presents a riddle clamoring for solution. The great prairie of the United States occupies an irregular area bounded on the east by a line that follows in a general way the ninety-fifth meridian and on the west by a line roughly extending along the ninety-seventh meridian. The eastern boundary is most irregular, its shape corroborating the fire origin of the prairie. In the north it makes a great bend eastward, enclosing half of Iowa, more than half of Illinois, and portions of Wisconsin and Indiana. Along its whole extension the prairie forms lobes and long tongues thrusting eastward into the forest. Since it is proved by the records of the Weather Bureau that the western boundary is within the limit of sufficient rainfall, capable of supporting tree growth, the whole area now occupied by the prairie is situated where forest ought to be, for there is neither lack of rain nor any condition in the soil or the vegetation that will account for the absence of trees. Mr. Gaskill assumes, therefore, that something not entirely normal caused the forest to retreat from its proper position. After a careful and detailed study of the records of forest and prairie fires in the states of Montana, Wyoming, Colorado, Texas, South

Dakota, Nebraska, Kansas, etc., he found that most of the fires occur there in the fall when the prevailing winds are from the west, and the vegetation of the plains lying to the windward of the area now prairie is exceedingly dry and combustible. The habit of the Indians of setting fire to the grass of the plains at that time of the year and its annual occurrence are matters of history. These annual fires, driven by strong westerly winds and finding no obstacle to their progress in the flat or gently rolling land, spread eastward until they reached the green timber. Year after year these fires ate their way a little farther into the forest, making the dense forest first more open and eventually entirely consuming it. The irregular projections of the prairie eastward into the forest are considered by Mr. Gaskill as the result of the work of the fires. Another evidence of its influence in causing the prairie he finds in the fact that with the settlement of the country and gradual elimination of fires the forest commenced to gain again on the prairie.

The prairies in other countries were also considered from the same point of view, and the speaker suggested that local students would probably confirm his opinion that fire has been an active agent in all such regions.

PRINCIPLES INVOLVED IN DETERMINING FOREST TYPES.

On February 23 Mr. Raphael Zon read before The Society of American Foresters a paper on forest types. These he identified as tree associations in the ecological sense, and not mere aggregations of trees as they often are conceived to be. Few will dispute the statement that the forest type is the cornerstone of silvics, and that the proper recognition of types in any forest is the first and most important question that a practical forester has to answer. "* * * The division of a forest into natural types of growth, however, is not such a simple thing as it may appear at the first glance. Stands differ from each other in many respects; they may be pure or mixed, even-aged or irregular, dense or open, of seedling or sprout origin, etc. Which of these features justifies the subdivision of the forest into types of growth, and what must we call a natural forest type? * * * When we attempt to trace to some definite causes the differences between stands composing a large forest, we finally come to two main ones: first, external physical conditions, such as climate, soil, moisture in the ground, topography, exposure, etc.; and second, interference by man, and natural accidents, such as fire, wind and so on. * * * It does not take very long to realize that segregating stands into types based on density, age or mode of origin can not be justified, since such features are not permanent and can not be characteristic of any definite forest type. * * * A forester who mistakes any such temporary forest growth for the original natural types of growth, thus failing to understand the natural evolution of the forest, will always have nature against him in all his operations, instead of being aided by her. * * * The physical conditions of the situation then are the main factors which determine the whole character of a forest type. Of these physical factors, climate undoubtedly has a marked influence upon plant life, if we compare vegetation of different latitudes. * * * Soil, moisture in the ground, and topography, to which in mountain countries must be added altitude and exposure, are the main factors which determine the character of forest growth in a forest region, and, therefore, must be accepted as the basis for the division of the forest into natural types of growth. A natural forest type then is an aggregation of stands which may differ from each other in age, density and other secondary features, but have the same physical conditions of situation, like soil, topography, exposure, etc. * * * The relationship between the physical conditions of the situation and the character of growth upon it is so constant and characteristic that by the given physical conditions of a situation, like soil, topography, and so on, one can describe the general character of its forest, the predominant species, habit of trees, reproduction, undergrowth and, *vice versa,* by a given type of the forest growth one can describe the physical conditions of growth, soil, situation, etc. * * * A forest

type is the result of a long struggle for existence between different species, in which only those possessing the greatest vitality and best fitted to the physical conditions of situation succeed in occupying the ground and form tree associations having a distinct physiognomy. One of the most important characteristics of a forest type is its stability, its resistance to invasion by other plant forms. * * *"

THE FOSSIL ARACHNIDA OF BOHEMIA.

WE are indebted to Professor Dr. Anton Fritsch for another important contribution on the Permian and Cretaceous fauna of Bohemia entitled 'Neue Fische und Reptilien.' This takes the form of a quarto appendix to his previously published volumes, and is illustrated by nine plates. The Cretaceous forms described are new teleosts, plesiosaurs, mosasaurs and pterosaurs.

In 1904 there appeared from the pen and brush of this ardent paleontologist a fine monograph on the Paleozoic arachnida, consisting of eighty pages of text and fifteen plates. The conclusions reached in this monograph are most striking, especially as to the very great antiquity of modern forms. The author observes "If we examine the entire series of the forms described we must recognize that there are many which present no very striking differences from the Arachnida of to-day. They are to be regarded as the direct ancestors of families now existing in part as lateral branches which have later become extinct." This is true of members of six families described. The scorpions of the Silurian period show in their foot structure a primitive form suggesting that of the Crustacea whereas those of the Carboniferous and Permian formations exhibit close resemblance to the foot structure of the modern types.

H. F. O.

EXTENDED EXPLORATIONS OF THE ATMOSPHERE BY THE BLUE HILL OBSERVATORY.

ACCOUNTS of the first experiments in this country with *ballons-sondes*, for the purpose of ascertaining the meteorological conditions at great heights above the American continent, appeared in SCIENCE, Vol. XXI., pp. 76–77 and 335. During the months of January, February and March, 1905, nine more ascents were made from St. Louis and every balloon but one was found and, with the attached instrument, was returned to Blue Hill in accordance with the instructions on each. Like the previous balloons, all of these fell within the eastern half of a circle having its center at St. Louis and a radius of 285 miles. The German expanding rubber-balloons, filled with hydrogen generated by the vitriolic process, were again employed, as were the French self-recording instruments, which gave at least partial records of barometric pressure and air-temperature in seven of the nine ascensions, although another record was obliterated by the finder. On January 25, when a high barometric pressure prevailed at the ground, a temperature of — 111° F. was recorded at the height of 48,700 feet, this being one of the lowest natural temperatures ever observed. The experiments last winter were conducted by Mr. Clayton, under the direction of Mr. Rotch, and their success induced Professor Langley, secretary of the Smithsonian Institution, to grant Mr. Rotch $1,000 from the Hodgkins Fund, in order to continue the experiments this summer at St. Louis. These, like the first, will be conducted by Mr. Fergusson, of the Blue Hill Observatory staff. Soundings of the atmosphere made at different seasons should reveal the annual variation of temperature at great heights above the American continent, which is at present unknown.

However, kites are not neglected at Blue Hill, for, besides the flights made there each month on the days fixed by an international committee, they are also being employed to ascertain the conditions above the Atlantic Ocean in the trade-wind region. Thus the investigation which was first proposed by Mr. Rotch in SCIENCE, Vol. XIV., pp. 412–413, and which has been persistently advocated by him since, is now in progress, and this was rendered possible through the cooperation of the well-known French meteorologist, M. L. Teisserenc de Bort, who placed his steam-yacht at the disposal of Mr. Rotch, on condi-

tion that the latter should share the expense of the cruise. Accordingly, on June 3, Mr. Clayton sailed from Boston for the Mediterranean on board the White Star steamer *Romanic,* equipped for raising self-recording instruments with kites, as was first done in 1901 by Messrs. Rotch and Sweetland, whose experiments on a voyage from Boston to Liverpool are described in SCIENCE, Vol. XIV., pp. 896–897. A despatch from Mr. Clayton, at Gibraltar, announced that flights had been made on six days and a mean height of 3,000 feet attained. The results of aerial soundings in the region of permanent high pressure around the Azores, and near the northern limit of the northeast trades, are expected to prove of special interest. At Gibraltar, Mr. Clayton is to embark on the *Otaria,* a yacht of 350 tons and capable of steaming eleven knots, which its owner has already employed for kite-flying in European inland waters. The boat will proceed south, touching at Madeira, Canary and Cape Verde Islands, and perhaps go as far as St. Paul, near the equator, returning by a more westerly course to the Azores, the whole voyage occupying about six weeks. On this route the northeast trade-winds and doldrums are traversed and the southeast trades entered. Should there be too little wind, either at the surface or higher up, the speed of the vessel will enable the kites to rise, and, should the wind at any time be too strong, by steaming with it the pull of the kites can be moderated. By this method it is hoped that all the strata up to a height of 15,000 feet or more will be penetrated, so that their condition as regards temperature, moisture and wind may be investigated. Besides determining the depth of the northeast trade-wind, the supposed southwest, or return trade, which has only been observed on the Peak of Teneriffe, will be sought and its height above the ocean in different latitudes measured, but in case the kites do not reach a sufficient altitude, it is proposed to liberate small balloons from Madeira and observe their change of direction as they rise. Professor Hergesell, on board the Prince of Monaco's yacht, executed last summer a series of kite-flights in the region between Spain, the Canaries and the Azores, without encountering the upper anti-trade, as was mentioned in SCIENCE, Vol. XXI., p. 464. The present expedition expects to make similar soundings in these and lower latitudes and will attempt to extend them to greater heights.

REGULATIONS GOVERNING THE SIXTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY.

THE sixth International Congress of Applied Chemistry, under the patronage of His Majesty the King of Italy, will be held at Rome in the spring of 1906. The president of the committee of organization is Professor Emanuele Paterno, Via Panisperna, Rome, and the secretary, Professor Vittorio Villavecchia, Central Customs Laboratory, Rome. All who are interested in promoting the applications of chemistry are eligible for membership in the congress. Active members are those who signify their desire to be such to the general secretary either before the opening of the congress or during its session, and who send the subscription fee, twenty francs. Donating members comprise those persons or societies who contribute the sum of at least one hundred francs or lire. Those who give a thousand lire or more belong to the list of patrons.

The congress is divided into the following sections and subsections:

1. Analytical chemistry, apparatus and instruments—president, Pietro Spica, professor of pharmaceutical chemistry in the University of Padua.

2. Inorganic chemistry and industries related thereto—president, Luigi Gabba, professor of technical chemistry in the Higher Technical School, Milan.

3. Metallurgy and mining, explosives; (*a*) metallurgy and mining—president, Ettore Mattirolo, Geological Survey, Rome; (*b*) explosives—president, Cav. Guiseppe Ninci, colonel of artillery, superintendent of powder of Fontana Liri.

4. Organic chemistry and industries related thereto; (*a*) industry of the organic products —president, Giacomo Ciamician, professor of general chemistry in the University of Bo-

logna; (*b*) coloring matters and their uses—president, Professor Guglielmo Koerner, director of the Higher School of Agriculture, Milan.

5. Technology and chemistry of sugar—president, Professor Vittorio Villavecchia, director of the Customs Laboratory, Rome.

6. Fermentation and starch; (*a*) fermentation, with special regard to enology—president, Mario Zecchini, director of the experiment station at Turin; (*b*) industry of starch and its derivatives—president, Professor Giglioli Italo, director of the experiment station of Rome.

7. Agricultural chemistry—president, Angelo Menozzi, professor of general chemistry in the Royal School of Agriculture, Milan.

8. Hygiene; (*a*) hygiene and medical chemistry—president, Icilio Guareschi, professor of pharmaceutical chemistry in the University of Turin; (*b*) pharmaceutical chemistry—president, Luigi Balbiano, professor of pharmaceutical chemistry in the University of Rome; (*c*) bromatology—president, Arnaldo Piutti, professor of pharmaceutical chemistry in the University of Naples.

9. Photochemistry, photography—president, Colonel Giuseppe Pizzighelli, president of the Italian Photography Society, Florence.

10. Electro-chemistry, physico-chemistry—president, Raffaello Nasini, professor of general chemistry in the University of Padua.

11. Laws, political economy and legislation in relation to industrial chemistry—president, G. B. Pirelli, Ponte Seveso 16, Milan.

The languages used in the discussion are Italian, French, German and English. The minutes of the proceedings of the session will be in Italian.

Those who intend to present papers and communications to the congress should send them to the general secretary at least two weeks before the opening of the congress. They should be written in one of the official languages of the congress, and as far as possible should be brief and succinct.

The congress shall consist of general meetings and meetings of the separate sections. There shall be at least two general meetings, of which the dates will be fixed by the committee. The sections may hold any number of meetings, and will work independently of each other.

The first general session shall be presided over by the chairman of the organizing committee. At this meeting the officers shall be elected, and shall include: an honorary president, and acting president, acting vice-president and honorary vice-presidents, a general secretary and assistant secretaries. In the last meeting of the congress at large shall be fixed the date and the place for the seventh congress of applied chemistry.

A president chosen by the nominating committee shall preside over the first meetings of the sections and subsections. In that meeting shall be elected a president, one or more vice-presidents, a secretary and one or more assistant secretaries. At the end of each meeting the president of the succeeding meeting shall be elected by vote. The president chosen by the nominating committee shall be a member of the board of the section in all its meetings.

The sections can modify their order from day to day. Actions shall be determined by a majority vote—in case of a tie the vote of the president shall decide.

The presentation of a topic shall not last more than twenty minutes, and during the discussion, speakers shall not occupy the floor for more than five minutes, nor speak more than twice on the same question, without special permission from the chair.

The minutes of a meeting shall include: (*a*) a summary of the papers presented, in the order in which they were given, the names of the speakers, and a summary of the ensuing discussion; (*b*) the decisions adopted in each meeting.

To make possible the accurate reproduction of the transactions of each meeting, the members who have spoken will send to the secretary of the section, at the latest, half an hour after the close of the meeting, a brief summary of the arguments of their papers. This summary shall be written in one of the four official languages. The secretary shall arrange the transactions, and transmit them, together with a list of the members present,

before twenty hours, to the general secretary of the congress.

Decisions of importance and international character adopted by the congress will be communicated to the governments participating in the International Committee of the Congress of Applied Chemistry, established at Paris in 1900.

After the close of the congress, a report will be printed containing the papers presented and the decisions adopted by the congress. This report will be sent free of charge to members.

All questions not provided for in this list of regulations shall be decided by the president, who shall continue in authority without cessation on matters pertaining to the present congress. Before he retires he shall place the conduct of affairs in the hands of an organizing committee for the next congress.

Dr. H. W. Wiley, at the request of the committee on organization, undertook the organization of an American committee, which is composed of members selected by President F. P. Venable on the part of the American Chemical Society, President R. W. Moore on the part of the New York section of the Society of Chemical Industry, and President H. S. Carhart on the part of the American Electro-Chemical Society.

Intending congressists may send their names and dues directly to the secretary of the congress, together with titles of papers to be presented at the meeting, or if preferred, to the chairman of the American committee, who will undertake to forward names, dues and papers to Rome. In case the dues are sent first to Washington for transmission to Rome, a check for $4.00 should be sent to cover dues, exchange and postage.

LIST OF MEMBERS OF THE AMERICAN COMMITTEE. SIXTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY.

Nominated by the Society of Chemical Industry (New York Section) and the American Chemical Society.

Dr. Charles Baskerville, chemist, College of the City of New York, New York.

Dr. Edward Hart, professor of chemistry, Lafayette College, Easton, Pa.

Dr. W. D. Horne, chemist, The New York Refinery, Long Island City, N. Y.

Dr. Leo Baekeland, research chemist, Snug Rock, Harmony Park, Yonkers, N. Y.

C. F. Chandler, professor of chemistry, Columbia University, New York, N. Y.

Nominated by the Electrochemical Society and the American Chemical Society.

W. D. Bancroft, professor of physical chemistry, Cornell University, Ithaca, N. Y.

C. F. Burgess, Madison, Wis.

Nominated by the Society of Chemical Industry (New York Section) and the American Electrochemical Society.

Dr. W. H. Walker, 93 Broad Street, Boston, Mass.

Nominated by the American Chemical Society.

Wm. A. Noyes, chemist, National Bureau of Standards, Washington, D. C.

J. D. Pennock, chief chemist, Solvay Process Co. and Senet-Solvay Co., Syracuse, N. Y.

Dr. Chas. E. Munroe, professor of chemistry, George Washington University, Washington, D. C.

Francis C. Phillips, professor of chemistry, Western University, Allegheny, Pa.

William McMurtrie, consulting chemist, Royal Baking Powder Co., New York, N. Y.

Dr. J. Merritt Matthews, Philadelphia Textile School, Philadelphia, Pa.

Mr. Clifford Richardson, director, New York Testing Laboratory, Long Island City, N. Y.

Dr. Samuel P. Sadtler, consulting chemist, Franklin Institute of Philadelphia, Philadelphia, Pa.

Dr. F. G. Wiechmann, consulting chemist, American Sugar Refining Co., Box 79, Station W, Brooklyn, N. Y.

David L. Davoll, Jr., chief chemist, Peninsular Sugar Refining Co., Caro, Mich.

Mr. G. L. Spencer, Bureau of Chemistry, Washington, D. C.

Dr. Max Henius, director, American Brewing Academy and the Scientific Station for Chicago, Chicago, Ill.

Charles E. Pellew, adjunct professor of chemistry, Columbia University, New York, N. Y.

Dr. Alfred Springer, chemist, 312 E. 2d Street, Cincinnati, Ohio.

Mr. B. W. Kilgore, director, North Carolina Agricultural Experiment Station, and state chemist, Raleigh, N. C.

Dr. Henry Adam Weber, professor agricultural chemistry, Ohio State University, Columbus, Ohio.

Chas. D. Woods, professor of agriculture, Uni-

versity of Maine, and director of Maine Agricultural Experiment Station, Orono, Me.

B. B. Ross, professor of chemistry, Alabama Polytechnic Institute, Auburn, Ala.

M. E. Jaffa, professor of chemistry, University of California, Berkeley, Cal.

Edward Kremers, professor of pharmaceutical chemistry, University of Wisconsin, Madison, Wis.

John Marshall, professor of chemistry, University of Pennsylvania, Philadelphia, Pa.

W. P. Mason, professor of chemistry, Rensselaer Polytechnic Institute, Troy, N. Y.

Dr. Chas. E. Doremus, assistant professor of chemistry, College of the City of New York, N. Y.

Edgar F. Smith, professor of chemistry, University of Pennsylvania, Philadelphia, Pa.

Dr. J. W. Mallet, professor of chemistry, University of Virginia, Charlottesville, Va.

Chas. B. Dudley, chief chemist, Pennsylvania R. R. Co., Altoona, Pa.

Mr. A. M. Todd, manufacturing chemist and distiller of essential oils, Kalamazoo, Mich.

Dr. Hugo Schweitzer, 40 Stone Street, New York, N. Y.

Mr. Maximilian Toch, 468 West Broadway, New York, N. Y.

Mr. Geo. C. Stone, chief engineer, New Jersey Zinc Co., 11 Broadway, New York, N. Y.

Dr. Theodore B. Wagner, The Rookery, Chicago, Ill.

Dr. William H. Parker, Office of the Appraiser, Boston, Mass.

E. F. Roeber, 114 Liberty Street, New York, N. Y.

Dr. J. W. Richards, Lehigh University, Bethlehem, Pa.

Mr. Hugh Rodman, 52–56 St. Clair Street, Cleveland, O.

Mr. W. McA. Johnson, care St. Nicholas Club, 7 West 44 St., New York, N. Y.

Mr. Henry Noel Potter, 510 West 23d Street, New York, N. Y.

Professor S. P. Sharples, Broad Street, Boston, Mass.

Dr. John A. Mandel, Bellevue Medical College, New York, N. Y.

ARTHUR WOODBURY EDSON.

ON Friday, June 23, Mr. Arthur Woodbury Edson, of the Bureau of Plant Industry, United States Department of Agriculture, died suddenly at Waco, Texas. The news of Mr. Edson's death came as a complete surprise and shock to his colleagues and friends in the department. The members of the Bureau of Plant Industry who had been closely associated with him held an informal meeting on Saturday afternoon, June 24, and passed resolutions of condolence and sympathy for his bereaved wife and parents. Dr. Erwin F. Smith, Dr. H. J. Webber and others gave expression to their regard for the man and their admiration of his scientific work.

Mr. Edson received his training in botany and in agricultural science at the University of Vermont, studying under Professor L. R. Jones and receiving the degrees of bachelor and master of science. Professor Jones early discovered his great promise, as he showed from the first great aptitude and enthusiasm for scientific work. While at Vermont he devoted a great deal of attention to the problems connected with the sap flow of the sugar maple. The bulletin upon that subject published a year ago by the Vermont Agricultural Experiment Station is based largely upon Mr. Edson's studies and experiments.

On July 1, 1901, Mr. Edson was appointed a scientific aid in the Bureau of Plant Industry, Department of Agriculture, entering at once upon plant breeding work, and assisting Dr. H. J. Webber in the breeding of long-staple upland cottons in South Carolina. Subsequently, Mr. Edson was promoted to the position of assistant physiologist, and was given charge of the plant breeding work upon cotton in Texas and adjacent states. When the plant breeding laboratory was called upon to cooperate with other organizations in the department in the cotton boll weevil investigations, Mr. Edson was entrusted with the direction of that part of the work. At the time of his death he had made great progress in producing not only earlier maturing varieties of cotton which escape the worst ravages of the pest, but varieties adapted to conditions in Texas having other desirable characters, such as greater yield, longer staple, larger bolls and easier picking qualities. Much as he had already accomplished along this line, he gave promise of even greater achievements, had not his untimely death cut short his work.

In view of Mr. Edson's many valuable qualities as an earnest and capable investigator, as

well as of the great importance and difficulty of the problem that had been put into his hands, the Department of Agriculture has sustained a very heavy loss in his death. His fellow workers feel that they have lost a more than usually upright and conscientious associate and a true-hearted, unselfish friend.

GEORGE HOMANS ELDRIDGE.

WE regret to record the death of Mr. Geo. H. Eldridge, geologist of the Geological Survey, which occurred on June 29. The Washington *Evening Star* says of Mr. Eldridge: "Born in Yarmouth, Mass., on Christmas day, 1854, he gained his early education at the Boston Latin School, where he took high rank in scholarship and in military affairs. Entering Harvard College with the class of '76, he devoted special attention to geological studies, and was taken on the 'varsity glee club. After graduation he taught until selected by Raphael Pumpelly as special expert on coal and base metals for the tenth census. At the conclusion of that investigation he was placed in charge of responsible work as geologist of the northern transcontinental survey and rendered valuable service in determining the extent and value of the coals of the Rocky Mountain region. In 1884 he entered the United States Geological Survey. For several years thereafter he was engaged in field work in several western states and Florida. In 1898 he was in charge of geological investigations in Alaska, and in recent years has been occupied almost entirely in making extended studies of special mineral deposits. Mr. Eldridge won an international reputation as an expert on asphalt, was an authority on phosphate and coal, and when his last sickness overtook him was engaged in preparing an exhaustive report on the oil of California. He has contributed valuable knowledge to the science of geology and has published 'Report on Montana Coal Fields,' 'Industries of the Base Metals,' an important portion of a monograph on 'Geology of the Denver Basin of Colorado,' 'Report on Asphalt and Bituminous Rock Products of the United States,' and numerous papers on various mineral deposits in this country and Alaska. He was a member of the American Institute of Mining Engineers, the Geological Society of America and the Geological, the Anthropological and the Harvard Societies of Washington.

SCIENTIFIC NOTES AND NEWS.

DR. E. RAY LANKESTER, director of the British Museum of Natural History, has been elected president of the British Association for the meeting to be held next year at York.

THE Rev. Dr. Nathan C. Schaeffer, Pennsylvania state superintendent of public instruction, has been elected president of the National Educational Association.

OBERLIN COLLEGE has conferred the degree of D.Sc. on the Rev. John C. Gulick, known for his work on the shells of the Hawaiian Islands and his theories regarding segregation and isolation as factors in organic evolution.

AMHERST COLLEGE has conferred its LL.D. on President Carroll D. Wright, of Clark College, and its D.Sc. on Mr. Henry Noel Potter, an electrical engineer of New York City, and on Dr. J. F. McGregory, professor of chemistry at Colgate University.

HOBART COLLEGE has conferred the degree of doctor of science on Dr. James M. Coit, teacher of natural science in St. Paul's school.

THE University of Dublin has conferred its doctorate of science on Professor E. A. Schäfer, professor of physiology at Edinburgh University, and on Professor Sydney Young, professor of chemistry, at University College, Dublin.

MR. T. A. RICKARD has resigned the editorship of the *Engineering and Mining Journal*, his resignation having taken effect on June 30.

DR. HARVEY W. WILEY, chief of the Bureau of Chemistry, of the Department of Agriculture, has gone to Europe under instructions from Secretary Wilson to make an exhaustive investigation of methods of preparing and preserving food products for shipment to America.

THE United States cruiser *Minneapolis*, conveying Rear Admiral Colby M. Chester, superintendent of the United States Naval Observatory, and the other members of the

government expedition which will observe the eclipse of the sun at Bona, Algeria, and Valencia, Spain, on August 29, has sailed for Spain. The auxiliary cruiser *Dixie* and the collier *Cæsar,* which have on board the instruments and materials for the observation stations, are also on their way to the Mediterranean.

IT appears from the daily papers that Professor Robert Koch, who is at present in German East Africa, has made important discoveries in regard to the transmission of tropical diseases.

M. ELIE METCHNIKOFF, vice-director of the Pasteur Institute, Paris, has been made an associate of the Belgian Academy of Sciences.

THE Guy silver medal of the Royal Statistical Society has been awarded to Mr. R. Henry Rew for his work on the production and consumption of meat and milk.

DR. ALBERT ORTH, professor of agriculture in the Berlin School of Agriculture, celebrated, on June 15, his seventieth birthday.

DR. E. WARBURG, president of the Reichsanstalt, has been appointed honorary professor in the University of Berlin.

DR. F. SIEGLBAUER, of Prague, has been appointed curator of the Anatomical Institute at Leipzig.

PROFESSOR J. VOLNEY LEWIS, of Rutgers College, will devote the summer to a special investigation of the petrography of the Newark (Triassic) traps of New Jersey and their associated copper ores for the State Geological Survey.

WE learn from *Nature* that the civil list pensions granted during the year ended March 31, include the following: 1904, August 8.—Mr. W. F. Denning, in consideration of his services to the science of astronomy, £150. August 8.—Miss Elizabeth Parker, in recognition of the services rendered to science as an investigator by her late father, Mr. W. Kitchen Parker, F.R.S., £100. August 8.—Lady Le Neve Foster, in consideration of the services rendered to mining science by her late husband, Sir Clement Le Neve Foster, F.R.S., and of the fact that his death was due to the effects of poisoning by carbonic oxide gas while carrying out his official duties, £100. 1905, January 17.—Dr. J. G. Frazer, in recognition of his literary merits and of his anthropological studies, £200. March 22.—The Rev. Lorimer Fison, in recognition of the originality and importance of his researches in Australian and Fijian ethnology, £150. March 22.—Dr. W. Cramond, in consideration of his antiquarian researches, more particularly in connection with the ecclesiastical and burghal history of Scotland, £80. March 22.—Miss L. C. Watts and Miss E. S. Watts, in recognition of the services of their late father, Mr. Henry Watts, to chemistry, £75.

THE Paris Aeronautic Club will erect in Paris a statue in memory of Philippe Lebon, the discoverer of illuminating gas.

A BUST of Michel Faraday by Mr. H. C. Fehr, presented to the Borough Polytechnic Institute, London, by Mr. Passmore Edwards, was unveiled on June 28 by Professor Sylvanus P. Thompson.

THE Berlin municipality has appropriated $20,000 to erect a statue in honor of Rudolf Virchow, which will be placed on the Karlsplatz, close to the Charity Hospital.

DR. WM. THOS. BLANDFORD, F.R.S., the well-known British geologist, died on June 23, at the age of seventy-three years. Mr. Blandford served on the Geological Survey of India from 1855 to 1882. He accompanied the Abyssinian expedition as geologist in 1868 and published on his return his 'Observations on the Geology and Zoology of Abyssinia.' He was also a member of the Persian Boundary Commission of 1872, and published a volume on the geology of eastern Persia. Dr. Blandford was a president of the Asiatic Society of Bengal from 1878 to 1879; president of the Geological Section of the British Association in 1884; president of the Geological Society of London from 1888 to 1890, and vice-president of the Royal Society from 1892 to 1893 and from 1901 to 1903. He was the recipient of the Abyssinian medal, the Royal medal of the Royal Society and the Wollaston medal of the Geological Society. He was the editor of 'Fauna of British India,' to which

he contributed one volume on mammals and two volumes on birds.

MR. JAMES MANSERGH, F.R.S., a British engineer, well-known for his work on water-supply and sewage, died on June 15.

THE government of the Argentine Republic has established a Meteorological Observatory on New Year's Island, which is expected to furnish valuable data from the South Atlantic Ocean.

WE learn from *The Athenæum* that Professor Karl Schröter and his pupil Dr. Rubel have established a biological station on the Bernina Pass. Although it is intended chiefly for the study of Alpine flora, attention will also be paid to meteorological observations, and the station is supplied with a complete equipment of meteorological and geodetic instruments. Professor Schröter's present idea is to keep the station open during the whole year, and similar stations are to be established in Puschlav and in the Upper Engadine.

WE learn from *Nature* that the Stephen Ralli memorial—a laboratory for clinical and pathological research—was opened at the Sussex County Hospital, Brighton, on June 29.

THE New York Board of Estimate has appropriated $17,000 towards exterminating the mosquitoes on Staten Island.

UNIVERSITY AND EDUCATIONAL NEWS.

THE board of regents has authorized the construction of a wing of the museum of the University of Nebraska.

THE tuition fees in Sibley College and the College of Civil Engineering at Cornell University have been increased from $125 to $150. A matriculation fee of $5 will be required of all students and the fees for graduation have been increased.

PROFESSOR E. J. WICKSON has been appointed acting director of the Agricultural Experiment Station of the University of California during the leave of absence granted to Professor E. W. Hilgard.

DR. KARL E. GUTHE, of the U. S. Bureau of Standards, formerly assistant professor of physics in the University of Michigan, has been appointed professor and head of the department of physics in the State University of Iowa.

DR. EDWARD BARTOW, associate professor of chemistry, at the University of Kansas, has been appointed associate professor of chemistry in the University of Illinois. He will have charge of the state water survey, and other sanitary work in the state.

PROFESSOR SAMUEL AVERY, who holds the chair of agricultural chemistry at the University of Nebraska, has been appointed professor of chemistry and director of the chemical laboratory, in succession to Professor H. H. Nicholson, who has resigned. In the same institution Mr. J. H. Powers has been appointed instructor in zoology.

THE regents of the Kansas State University have made the following appointments: P. F. Walker, of the University of Maine, to be associate professor of mechanical engineering; H. A. Rice, of Lehigh, assistant professor of civil engineering; N. J. Wheeler, of Purdue University, assistant professor of civil engineering; Dr. M. F. Sudler, of Johns Hopkins and Cornell Universities, assistant professor of anatomy.

MR. G. E. CONDRA has been promoted to an assistant professorship of geography and economic geology in the University of Nebraska.

MR. GEORGE D. HUBBARD, instructor in geology and physical geography in Cornell University, has been elected assistant professor of geology in Ohio State University. The other members of the geological department are Charles S. Prosser, professor of geology, and John A. Bownocker, professor of inorganic geology.

THE Paris Academy of Sciences has nominated M. Verneuil as its first choice for the chair of ceramics, and M. Rosenstiehl for the chair of dyeing, in the National Conservatory of Arts and Measures.

DR. ERNST MEUMANN, of Zurich, has been called to the chair of philosophy at Königsberg.

DR. RITCHIE, reader in pathology at Oxford, has been made professor.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, JULY 21, 1905.

CONTENTS.

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

*THE ORGANIZATION AND ADMINISTRATION OF NATIONAL ENGINEERING SOCIETIES.**

THE most important factors in promoting the advance of the engineering profession and in disseminating and rendering available to the world the valuable experience and data accumulated by engineers in the practise of their profession, are the professional associations of national engineering societies. The importance of the interchange of data and results of observation and experience was recognized by engineers long before the practise of engineering had been exalted to the dignity of a profession.

While military engineering was recognized from the earliest times and great military engineers such as Vauban, and bridge and highway engineers such as Perronet, had achieved eminence, it was manifestly impracticable for military officers to organize for the purpose of interchange of information, on the very secrecy of which the military establishments of nations were dependent for their offensive and defensive efficiency. The first important step in the association of engineers into a professional body was taken when in 1828 Thomas Telford, in the name of 156 of his colleagues—some of whom had already formed a society as early as 1818—applied for royal charter for the Institution of Civil Engineers (of Great Britain). The original charter recites that the body is formed "for the general advancement of mechanical science, and more particularly for promoting the

* Presidential address, American Institute of Electrical Engineers, twenty-second annual convention, Asheville, N. C., June 19, 1905.

acquisition of that species of knowledge which constitutes the profession of a civil engineer, being the art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation, and docks, for internal intercourse and exchange, and in the construction of ports, harbors, walls, breakwaters and lighthouses, and in the art of navigation by artificial power for the purposes of commerce, and in the construction and adaptation of machinery, and in the drainage of cities and towns."

It will be seen that this famous definition of the field covered by the profession of the civil engineer, as formulated by Telford, covers broadly all of the branches of modern engineering science, excepting military engineering, and includes within its scope directly or by implication mechanical, mining, electrical and sanitary engineering and naval architecture. It was not long before important discoveries in the realm of physical science and epoch-making inventions and improvements in the mechanical arts opened new fields of industrial activity, and we find this broadening of the field covered by the engineer reflected in a differentiation of the profession, in Great Britain resulting in the organization in 1847 of the Institution of Mechanical Engineers, in 1869 of the Iron and Steel Institute, and in 1871 of the Society of Telegraph Engineers and Electricians, which became in 1889 the Institution of Electrical Engineers.

Coming now to our own country, the American Society of Civil Engineers was organized in 1852, the American Institute of Mining Engineers in 1871, the American Society of Mechanical Engineers in 1880 and the American Institute of Electrical Engineers in 1884. While these are the distinctively national engineering societies, there are other technical associations like the Society of Naval Architects and Marine Engineers, the American Society of Heating and Ventilating Engineers, the American Street Railway Association, Association of Engineering Societies, etc., which, although of national importance, do not come within the scope of our subject.

There are still many other professional bodies in the United States identified with the engineering profession, some of a national character, which in addition to professional activities are also associated for commercial relations and whose memberships consist largely of business corporations, such as the National Electric Light Association and the Association of Edison Illuminating Companies, and still others largely local in character, such as the Pacific Coast Transmission Association, the Engineers' Society of Western Pennsylvania, and the league known as the Association of Engineering Societies, representing a total membership of 1,766 in eleven local engineers' clubs or societies.

In this review we shall confine ourselves to the four national engineering societies first referred to, with some reference to the corresponding bodies in Great Britain and on the continent.

NATIONAL ENGINEERING SOCIETIES (U. S.).

Name and Date of Organization.	Date of Report.	Hon. Members.	Full Members.	Asso. Members.	Associates.	Junior Members.	Total.
American Society of Civil Engineers, 1852	Jan. 1, 1905	9	1793	903	127	[1]367	3203
American Institute of Mining Engineers, 1871	Jan. 1, 1905	7	3483	—	190	—	3680
American Society of Mechanical Engineers, 1880	Jan. 1, 1905	19	1915		237	609	2780
American Institute of Electrical Engineers, 1884	Jan. 1, 1905	2	481	2851	—	—	3334

[1] Including 27 fellows.

The membership of these bodies, divided into the several classes according to their last official reports, is given in the following table; as a matter of general interest there is also added a tabulation of the more important European engineering societies.

FOREIGN ENGINEERING SOCIETIES.

Name and Date of Organization.	Date of Report.	Hon. Members.	Full Members.	Asso. Members.	Associates.	Total.
Institution of Civil Engineers (of Great Britain), 1818	Jan. 1, 1905	19	2191	4116	271	[1]6597
Institution of Mechanical Engineers, 1847	Mar. 1, 1905	9	2351	1545	72	[2]3977
Iron and Steel Inst., 1869	Jan. 1, 1905	11	1898	—	—	1909
[3] Institution of Electrical Engineers, 1889	Aug. 31, 1904	6	[4]1101	1435	1761	[5]4303
Verein Deutscher Ingenieure, 1891	Apr. 24, 1903	6	17543	—	—	17549
Société des Ingénieurs Civil de France, 1848	1901	—	—	—	—	3691

A study of the annual reports of these bodies from year to year and of their constitutions and by-laws is of considerable interest, showing their progressive expansion, growing influence, and higher professional standing from year to year, and the lines along which these developments take place. We will not undertake a retrospective analysis, however, but rather confine ourselves to a comparative study of the methods of organization and business administration of the four national engineering societies as revealed in their last annual reports. It should be stated at the outset that this study is not undertaken with a view of criticizing the methods followed or results accomplished by our sister societies, but for the purpose of profiting by their experience and, if possible, avoiding in our own rapidly growing body any abnormal development which may detract from its efficiency as a whole, or result in purely local development at the sacrifice of general usefulness and national standing.

[1] Not including 1,114 students or graduates.

[2] Not including 450 students or graduates.

[3] Originally organized as the Society of Telegraph Engineers and Electricians in 1871.

[4] Includes 136 foreign members.

[5] Not including 1,107 students or graduates.

One of the very first questions we encounter is that of the grades of membership, then the requirements of admission to them, and the method of election. These questions are of fundamental importance and they are worthy of the closest attention, as upon them more than upon any other feature of the organization will depend the professional standing of the society and its healthy growth in membership and influence. There is no honor within the gift of the society which requires the exercise of so much judgment, such fidelity to its interests, such conscientiousness, impartiality and impersonality, as membership on the Board of Examiners or Committee on Admissions, and it is deserving of the highest recognition.

The requirements for honorary membership demand no lengthy discussion, as the practise of all of the societies is essentially identical in this respect.

The requirements for full membership vary greatly in the four societies, as we shall see from abstracts from their constitutions.

AMERICAN SOCIETY OF CIVIL ENGINEERS.

Constitution—Article II.—Membership.

2. A Member shall be a Civil, Military, Naval, Mining, Mechanical, Electrical, or other professional Engineer, an Architect or a Marine Architect. He shall be at the time of admission to membership not less than thirty years of age, and shall have been in the active practise of his profession for ten years; he shall have had responsible charge of work for at least five years, and shall be qualified to design as well as to direct engineering works. Graduation from a school of engineering of recognized reputation shall be considered as equivalent to two years' active practise. The performance of the duties of a Professor of Engineering in a technical school of

high grade shall be taken as an equivalent to an equal number of years of actual practise.

AMERICAN INSTITUTE OF MINING ENGINEERS.

Constitution—Article II.—Members.

Sec. 3. The following classes of persons shall be eligible for membership in the Institute, namely: As Members, all professional mining engineers, geologists, metallurgists or chemists, and all persons practically engaged in mining, metallurgy or metallurgical engineering.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Constitution—Membership.

C 9. A Member shall be thirty years of age or over. He must have been so connected with Engineering as to be competent, as a designer or as a constructor, to take responsible charge of work in his branch of Engineering, or he must have served as a teacher of Engineering for more than five years.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

Constitution—Article II.—Membership.

2. A Member shall have been an Associate, and at the time of his transfer to membership he shall be not less than twenty-seven years of age, and shall be:

a. A Professional Electrical Engineer; or

b. A Professor of Electrical Engineering; or

c. A person who has done important original work, of recognized value to electrical science.

3. To be eligible to membership, as a professional Electrical Engineer, the applicant shall have been in the active practise of his profession for at least five years; he shall have had responsible charge of work for at least two years, and shall be qualified to design as well as direct electrical engineering works. Graduation from a School of Engineering of recognized standing shall be considered the equivalent of one year's active practise.

4. To be eligible to membership as Professor of Electrical Engineering, the applicant shall have been in responsible charge of a course of Electrical Engineering at a college or technical school of recognized standing for a period of at least two years.

It will be seen that two of the societies fix an age limit of thirty years, one twenty-seven years and one fixes no limit; one requires professional practise of ten years, one five years, two no time specified; three require professional competency in designing as well as constructing or directing engineering works, one requires the applicant to be professionally or practically engaged in the branch.

In the case of the Mechanical Engineers and the Civil Engineers the election is by ballot of the membership at large after approval by the executive board or council; in the case of the Mining Engineers and Electrical Engineers, election is by direct vote of the board of directors, in the latter after submitting the names to the membership at large, in the former without submission. In the Mining Engineers, Mechanical Engineers and Electrical Engineers the application is first passed upon by a board of examiners and then by the executive board or council; in the case of the Civil Engineers by the board of directors directly without action by an examining board. The Electrical Engineers' constitution requires that all members be first elected as associates and then transferred by the board.

It will be seen from the above how different the requirements are for full membership in the several societies, and how varied the procedure for election. It would appear at first thought that the more explicit the constitution in its exact definition of the conditions for membership the easier it would be for the membership committee to act; but this is by no means always the case, as it often prevents the taking of a broad view of the candidate's eligibility and is apt to exclude desirable material on very technical grounds, although on the other hand it is a protection against loose interpretation of the requirements by careless examiners. There would seem to be a better division of responsibility and more direct control of the class of men admitted to membership by giving wide publicity to their candidacy and election

by ballot by the membership at large, after the candidates have passed the scrutiny of the board or an examining committee. A young society covering a branch of engineering that has but recently become specialized can not in the beginning impose rigorous requirements as to age limits or time of professional service and the branch of engineering may be such as to make it difficult to impose severe technical requirements.

In the case of the Civil Engineers the accepted definition is sufficiently broad to cover applicants who are professionally engaged in any of the other branches of engineering; the Mechanical Engineers' definition is somewhat less comprehensive, the Mining Engineers' still less so, and the Electrical Engineers' really restrictive to professional electrical engineers. Under our institute's constitution, however eminent a man may be as a civil, mechanical or mining engineer, he may not fulfil the qualifications of an electrical engineer. It will thus be seen that anything like standardization in the matter of requirements is wholly out of the question, although a greater uniformity in requirements and procedure for election would be advisable. It is very difficult for an applicant in every respect qualified for full membership in our institute to understand why it should be necessary for him to pass through the preliminary, or, as it were, probationary grade of associate, and then be transferred to full membership, but the constitution is clear. Applicants whose superior qualifications would entitle them to immediate election to full membership after their election to the preliminary grade of associate, which takes some time—several months at least—are apt to fail to make application for transfer, with the result that many remain in the associate grade who should certainly be transferred, and when they find the cause of the delay are apt to criticize the administration.

We now come to the consideration of the other grades of membership, associate membership, associates, juniors, etc. It would lead us too far afield to treat each grade in full and we shall confine ourselves to some general observations. It is necessary to provide one or more grades for young men just entering professional life and through which they can rise as they acquire experience to the dignity of full membership; but it is necessary to provide also for another class of men who, while they are not professional engineers, yet cooperate with them and conduct engineering works, acting as the executive heads or business managers. To such men eminent in their particular branch of activity it is humiliating to be placed permanently in an inferior grade of membership with the beginners in professional service, and the situation can be satisfactorily met by the establishment of the grade of associate; junior and associate membership then to represent successive steps in the advancement to full membership, the associates forming a class by themselves.

We now come to the question of the dues and at the same time we may, with advantage, consider the general question of the income and expenditures or the cost of conducting the business of the societies.

The expense of membership in the several societies is as follows:

	Entrance Fees.			Annual Dues.			Foreign.	
	Juniors.	Associates.	Members.	Juniors.	Associates.	Members.	Associates.	Members.
Amer. Society Civil Engineers	$10	$20–25	$30	$10–15	$10–15	$15–25		
Amer Institute Mining Engineers	—	10	10	—	10	10		
Amer. Society Mechanical Engineers	15	25	25	10	15	15		
Amer. Institute Electrical Engineers	—	5	15	—	10	15	5	10

In view of the new relations entered into between the three national engineering societies, which are to occupy jointly the Union Engineering Building, and as the societies have now roughly about the same membership, it would appear to be desirable to have membership dues as nearly on a uniform basis as practicable.

It would appear that the entrance fees of our institute might be revised without disadvantage, increasing the entrance fees for associate to at least $10 and a payment of an additional $15 on transfer, a total of $25 for full membership. An increase in annual dues also is not at all improbable in the near future, and they might with advantage be increased to $15 for resident associates (within fifty miles of New York) and to $25 for resident members; this increase for resident membership would seem to be warranted by the greater advantages enjoyed by the membership residing in or near New York, more especially after the occupancy of the Union Engineering Building.

RECEIPTS AND DISBURSEMENTS PER YEAR PER MEMBER.

Receipts.	Civil.	Mining.	Mechanical.	Electrical.
Entrance Fees	$2.59	$0.28	$2.45	$0.83
Dues	16.99	10.64	14.04	9.30
Transactions, Sales and Adv	1.86	2.09	1.64	1.70
Badges and Certificates	.65	—	—	.28
Interest	.36	.34	—	.21
	$22.45	$13.35	$18.13	$12.32
Disbursements:				
Transactions	$4.63	$5.28	$7.50	$3.77
Salaries, etc	6.13	4.22	3.99	2.20
Meeting Expenses	.29	.30	.94	.82
Library, including Rent and Salaries	.30	.80	.39	.81
Rent	2.84	.74	2.79	.75
Stationery and Miscellaneous Printing	.62	.34	1.19	.70
Postage	1.10	1.02	.26	.66
General Expenses	.34	.47	.11	.54
Badges and Certificates	.50	—	.38	.25
Express	—	.83	—	.22
Totals	$16.75	$14.00	$17.50	$10.72
Credit Balance per Member	$5.70	$0.65 (Deficit.)	$0.63	$1.60

Let us now consider the annual receipts and disbursements per paying member per year in the four societies. These figures are presented purely as a matter of general interest and not at all of invidious comparison; the table of receipts and disbursements per member is subdivided under appropriate heads as accurately as they can be compiled.

It should be borne in mind that no deductions of value can be drawn from a mere comparison of these figures alone; take the cost of the transactions, for instance, in order to make a comparison of the relative economy with which this item is handled in the several cases, it would be necessary to know in each instance the number of pages, number of cuts, number of advance copies distributed at meetings or in monthly advance publications in addition to the regular annual volumes. The figures, therefore, represent the amounts which are being spent on the several items, rather than a comparison of their economic handling; it would be fallacious to assume that the figures necessarily represent the comparative economy with which the societies conduct the items in the table.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
RECEIPTS AND DISBURSEMENTS PER YEAR PER MEMBER.

During each fiscal year for the past five years.

Year.	1901.	1902.	1903.	1904.	1905.
Membership	1260	1549	2230	3027	3460
Receipts:					
Entrance Fees	$0.61	$1.16	$1.59	$1.65	$0.83
Dues	8.61	10.06	9.01	9.33	9.30
Transactions, Sales and Adv	1.03	1.54	1.79	2.11	1.70
Badges	.18	.26	.35	.39	.28
Interest	.12	.24	.21	.18	.21
	$10.55	$13.26	$12.95	$13.66	$12.32
Disbursements:					
Transactions	$2.83	$3.50	$4.67	$3.43	$3.77
Salaries	2.49	2.78	2.49	2.50	2.20
Meeting Expenses	1.05	1.13	.87	1.16	.82
Rent	.94	.94	.65	.79	.75
Library, including Rent and Salaries	.55	1.85	1.38	1.39	.81
Postage	.46	.51	.69	.66	.66
Stationery, Miscellaneous Printing	.39	.53	.96	1.01	.70
General Expenses	.33	.59	.52	.45	.54
Badges	.16	.19	.27	.35	.25
Express	.15	.15	.15	.28	.22
Total	$9.35	$12.17	$12.95	$12.02	$10.72
Credit Balance per Member	$1.20	$1.09	$0.00	$1.64	$1.60

It may also be interesting to compare the receipts and disbursements per institute member during the past five years, in which the membership has increased from 1,260 to 3,460.

Our next concern is with the officers of the societies and the method of nomination and election. A truly national society should draw its membership from all parts of the country and should afford representation in its officers and on its administrative committees to the membership at large; in other words, should select its officers as far as possible with a view also to geographical distribution. It is admitted that this is difficult, owing to the opportunities afforded to practising engineers by large enterprises whose administration, technical as well as financial, is located in the important commercial centers, hence the important groups of members in the large cities. From these are drawn the majority of the officers, such selection being emphasized by the necessities of the central administration of the society. Such tendencies, however, are apt to operate to the disadvantage of available candidates for the important posts of honor within the gift of the societies who may happen to be stationed some distance away from headquarters, and to keep the institution on the plane of national standing it should also have a care to broad geographical distribution. This end can best be accomplished by providing for a nominating committee selected according to a geographical distribution into approximately equal groups of members, each geographical district consisting of, say, 300 or 400 members, and upon these, in consultation with a number of past officers, would rest the selection of the official nominees, with provision also for the filing of such nominations as may be made directly by the general membership. This procedure was introduced by the American Society of Civil Engineers several years ago. Such a plan would provide geographical representation and at the same time discourage unseemly electioneering and circularizing for the coveted posts of honor. It is thought by some that our own institute could with advantage modify its own procedure in this direction.

We would add further that the election once accomplished, the officers-elect could again, with advantage to the interests of the institute, take office at once at the close of the annual meeting, or at latest as the last act of the annual convention. The supercession of the retiring president and officers and the installation of the new should be an official function before a general institute meeting, a deficiency of our present method of procedure, which now allows four months to elapse after the election of the new officers before they actually take office, and within three months or at most four months after taking office the active canvass for their successors already begins. It will be admitted by all with experience in the administration of professional societies that it is most desirable to eliminate all tendencies to political agitation in connection with the election to the honors within the gift of the membership, concentrating all efforts on the advancement of the professional standing of the society and the interests of its members. It would also seem to be of advantage to have the fiscal year coincident with the calendar year; this would bring the annual meeting less close to the annual convention and, spreading it over several days, would secure a larger attendance of the out-of-town membership for the annual business meeting and the annual banquet or other functions could be held at this time. The annual meeting as held at present is not markedly distinguished from the other monthly meetings, and there is usually only

a month between it and the annual convention. With the growing importance of the financial interests confided to the care of the successive administrations the yearly business meeting should have larger attention and participation from the membership at large than is the case at present.

The administration of the societies should be in the hands of their board of directors or councils, and similarly the important standing committees in whose hands rests the conduct of the routine in the several branches of administration should be committees of the board or council. Such being the case, it is desirable that their appointment should in the beginning rest with the board itself, one member of each standing committee retiring each year and the new president filling the vacancies, a much more satisfactory arrangement than the plan followed by our institute at present, under which the responsibility of the appointment of all the committees, standing as well as special or temporary, rests alone with the president. The suggested plan of appointment of the administration committees primarily by the board or council, the president filling the vacancies that occur each year, is not the one usually followed by our national societies, but even where all the appointments devolve on the president alone, membership on the standing committees is, as a rule, limited to members of the board. The advantage of selecting the standing committees from the members on the board is evident, as the committees are then not apt to follow a policy at variance with the wishes of the executive body, disturbing harmonious relations and continually raising questions of jurisdiction.

It is also desirable to avoid constant changes in the personnel of such important committees as the finance, library and membership committees; provision should be made for standing committees of three or five, with one member retiring each year, the new members to be appointed by the incoming president. Such a plan secures continuity of policy, gives the committees the benefit of accumulated experience and relieves the president of the responsibility of making such a large number of new appointments on entering his term of office. Such standing committees as finance, membership, library, publication and meetings, or the last two consolidated into one, are necessary for all societies, together with such other committees as the particular field covered by the work of the society may require. Outside of the standing committees required by the regular routine, it is desirable to avoid as far as practicable the appointment of special or temporary committees, and these, when the special work assigned to them has been performed, should be discharged. There is nothing more subversive of effective and energetic administration than board meetings at which an interminable series of committees make 'no report' or the chronic 'report of progress.'

In case it is considered advisable to appoint a separate 'committee on meetings' or 'papers and meetings' and a 'committee on publications' or 'editing committee'—a division of work which becomes necessary when monthly meetings are held with reading of papers and discussions, as well as one or more annual meetings—it becomes necessary to define their respective responsibilities very clearly, placing upon the committee on meetings or papers the responsibility of the acceptance of the paper or communication for presentation at the meeting, and upon the publication or editing committee alone the responsibility for the publication of the paper or discussion, as a whole or in part, in the official transactions of the society.

It might be observed here that great care

should be exercised in the conduct of a society occupied with a specific branch of engineering, that as far as practicable all of its divisions receive due consideration. In an institute of electrical engineering, telegraph and telephone, electric traction and electric lighting, central station and isolated plant, transmission and distribution, design and construction, theory and practise, in fact all branches of electrical engineering, should receive consideration, and in the solicitation of papers for the series of meetings held during the year a wide range of subjects should be covered so as to interest and attract the largest circle of members.

We have already referred to the importance of conducting a national society on broad lines so that the members at large should have a share in the benefits as well as the obligations of membership, whether they be located near the headquarters of the society or at a distance. It is manifest that when the monthly meetings, as well as the more important annual functions, are held at the headquarters of the society, the members at a distance feel that they are at a disadvantage, and there is a tendency to form local clubs or organizations and secede from the parent society or at least lose interest in it. Our institute has met this situation courageously, and through the initiative of Past-president Scott a series of local organizations was established and they have been added to under succeeding administrations; these organizations have done much to keep up the interest at distant points and they have undoubtedly induced desirable accessions to our membership and have been an important stimulant of professional activity.

Our sister societies are facing the same problem and are watching the result of our undertaking—it can no longer be called an experiment—with great interest. But this scheme of local organizations, while undoubtedly successful, is developing new problems and new conditions and requires the constant care and supervision of the central administration.

As the close of another administrative year draws near I have felt it incumbent upon myself, and the fulfilment of a duty, to direct your attention to some of the questions which are before us and to give expression to a few thoughts that have occurred to me as a result of some years' experience in connection with the administrative work of our own society and a study of the methods followed by our sister engineering societies.

The comparisons which have been presented and the suggestions offered are not made in a spirit of criticism, nor am I unmindful of the splendid work accomplished by the framers of our present constitution, to whom the highest credit is due for an altogether excellent compilation, but our institute is growing rapidly and with its expansion new problems are arising, its field of activity is constantly broadening, and it should be expected, therefore, that modifications in its organic law may from time to time become necessary.

It is in meeting and solving such new problems of society administration as I have referred to, that the youth and enthusiasm of our members are of the utmost advantage; we are less handicapped by precedent and tradition than some of our older sister societies, and we may, therefore, expect for the Institute of Electrical Engineers a glorious future full of activity, initiative and prosperity, and successful in the attainment of the highest professional standing, dignity and usefulness.

JOHN W. LIEB, JR.

THE THIRTY-SECOND GENERAL MEETING OF THE AMERICAN CHEMICAL SOCIETY, HELD AT BUFFALO, N. Y., JUNE 22–24.

OPENING SESSION.

An address of welcome was delivered by President T. Guilford Smith, of the Buffalo Society of Natural Sciences, and the response by Francis P. Venable, president of the Chemical Society. An address on 'The Classification of Carbon Compounds,' by Professor Marston T. Bogert, and one on 'Some Recent Advances in Physiological Chemistry,' by Professor John H. Long, followed. It is probable that both of these addresses will be published later. The following papers were presented:

Note on the Atomic Weight of Carbon: Charles L. Parsons.

As the analyses made during the determinations of the atomic weight of beryllium were of two compounds containing exactly the same elements, two simultaneous equations were obtained which would yield the atomic weights both of beryllium and of carbon, each entirely independent of the other. The calculation gave the figure 12.007 for carbon and 9.112 for beryllium, which is highly confirmatory of the correctness and accuracy of the work on beryllium published in the *Jour. Am. Chem. Soc.*, **26**, 721.

Chemical Glassware: Percy H. Walker.

A series of tests for durability and solubility of beakers and flasks, with analyses and tests of a number of different glasses, was reported upon. The zinc borosilicate glasses are distinguished by permanent trade marks, and are much more resistant to changes of temperature, less soluble in water and carbonated alkalis, but somewhat more soluble in caustic alkalis, than the alkali-lime silicate glasses. The zinc borosilicate glasses are generally of good quality, but much of the alkali-lime silicate glass on the market is very poor.

An Apparatus for Determining the Viscosity of Liquids at Different Temperatures, and *An Apparatus for Determining the Flash-point of Inflammable Liquids:* F. Courtois.

These pieces of apparatus are described and illustrated in the *Scientific American*, May 20, 1905 (p. 408). One of the main features of the flash-tester is the uniformity of level insured by an overflow compartment.

MEETINGS OF THE SECTIONS.

During part of the time the society met in the form of sections, before which most of the papers were read. These were: Section of General and Physical Chemistry, Willis R. Whitney, chairman; Section of Organic Chemistry, Marston T. Bogert, chairman; Section of Agricultural, Physiological and Sanitary Chemistry, John H. Long, chairman; Section of Inorganic Chemistry, L. M. Dennis, chairman. The papers read were:

Vapor Pressure of Sulphur at 100° C.: Hippolyte Gruener.

Dry carbon dioxide, hydrogen and air were passed over sulphur heated to 99°.80 C., saturation of the gas being assured. The sulphur volatilized was collected on the walls of a detachable tube and thus weighed. The results from these gases agreed within 5 per cent., and the vapor pressure calculated from the mean, for S_8, is 0.00718 mm. For 70°, 80° and 90° the vapor pressures are 0.00061 mm., 0.00156 mm. and 0.00287 mm., respectively.

Confirmatory results were obtained by boiling water with sulphur and weighing the sulphur carried over by the escaping steam.

On a New Dynamic Method of Measuring Vapor Tensions of Solutions: Louis Kahlenberg.

This method consists in slowly drawing a known volume of air *over* the liquid whose vapor tension is to be measured, the liquid being placed in a large horizontal glass tube which is constantly agitated to insure complete saturation of the air with the vapor, but not so as to produce spray. The material thus carried over by the air is absorbed in appropriate apparatus and weighed. In the case of solutions a measurement is also made with the pure solvent.

Apparatus for Vapor Heating: H. R. CARVETH and J. P. MAGNUSSON.

The paper reviews the various forms of apparatus which have been suggested for the determination of molecular weights by the vapor heating method and presents a new form. Its distinguishing feature is that while it still permits of the return of the condensed liquid to the boiling flask the latter, being separate from the vapor heater, may in case of breakage be readily replaced.

Tensile Strengths of Aluminum Zinc Alloys: W. D. BANCROFT.

A New Use for the Dilatometer: W. LASH MILLER.

The Hydrolysis of Ammonium Acetate and the Ionization of Water at High Temperatures (100°–156°): ARTHUR A. NOYES and YOGORO KATO.

The figures below are computed from conductivity measurements made with a specially constructed apparatus previously described. Percentage hydrolysis of ammonium acetate at one one-hundredth normal (values vary but slightly with concentration): at 18°, 0.5 per cent.; at 100°, 5.2 per cent.; at 156°, 17 per cent. Ionization constants:

	Water.	Acetic Acid.	Ammonium Hydroxide.
18°	0.66×10^{14}	18.3×10^{6}	17.1×10^{6}
100	48 "	11.4 "	14.0 "
156	155 "	5.6 "	6.6 "
218	200 "	1.9 "	

It will be noticed that the increase in the constant of water and the decrease in those of the acid and base act together in producing increased hydrolysis at high temperatures.

Equilibrium in the System, Beryllium Oxide—Oxalic Acid—Water: CHAS. L. PARSONS and W. O. ROBINSON.

Equilibrium studies of the oxalates of beryllium show that the basic oxalates which have found their way into chemical literature have no basis in fact, but are solid solutions of indefinite composition. The acid oxalate of beryllium also can not be made. The one definite compound of these three components is $BeC_2O_4 + 3H_2O$ at ordinary temperature and $BeC_2O_4 + H_2O$ obtained by heating the first to 100°.

The Phosphates of Calcium: F. K. CAMERON.

In the system $Ca—Po_4—H_2O$, the equilibrium is reached at 25° C. at a slow rate. The ratio PO_4/Ca in the solid phase was found to be 4.6 at a concentration of Ca above 55 grams, and of PO_4 above 423 grams, per liter of solution. Between this point and the second point, whose exact position is still under investigation, the ratio PO_4/Ca in the solid phase was 2.4. At lower concentrations of PO_4 the ratio PO_4/Ca in the solid phase varied continuously from about 2.1 to 0. This shows that at higher concentrations the solid phase is monocalcium phosphate; at intermediate concentrations the solid phase is dicalcium phosphate, and at lower concentrations there is one, or possibly two, series of solid solutions.

The Transmutation of the Elements: H. J. BARNES.

A Strong, Sterilizable, Dialyzing Membrane: H. W. HILL.

Some Notes on Rock Decompositions: ALLERTON S. CUSHMAN.

In studying the action of water on rock powders, the principles of electrolysis and electrical endosmosis were resorted to, since on simple extraction and filtration the insoluble colloid or 'pectoid' decomposition products retain the alkalis. These investigations are as yet unfinished, but it is hoped by this means to study the actual kaolinization of the feldspars in the laboratory. It is also hoped that the determination of the endosmotic constant, according to Wiedermann's formula, of different rock powders will furnish a means of accurately ascertaining the relative rate of decomposition under the action of water.

Some Observations on the Deposition of Alloys from Mixed Solutions: C. B. Jacobs.

In studying the simultaneous deposition of two metals from a mixed solution of their salts, the author found that the difficulty of preventing the solution from attacking and dissolving the more electropositive metal after deposition could be overcome by the use of two anodes, one of the electropositive metal and one of the electronegative metal, connected to separate generators running at different voltages, the current returning through the cathode in the bath by a common third leg to the generators. Alloys of zinc and nickel and of zinc and copper were deposited in this manner from neutral sulphate solutions. With cyanide solutions of copper and zinc a great variety of brass work was plated from the same bath by changing the voltage on either anode, so as to deposit a brass running high in copper and low in zinc, or *vice versa.*

Some Properties of the Metal-Ammoniums: C. A. Kraus.

A study was made of the conductivity and of the conductivity temperature coefficient of the metal-ammonium solutions, from which it develops that the properties of these solutions are very different from those of salt solutions in ammonia. Migration experiments were carried out which show that a metal-ammonium solution may behave like a metallic electrode. The process of solution of a metal in ammonia is not accompanied by electromotive forces. The bearing of the optical properties on the problem of the metal-ammoniums was briefly pointed out.

A Determination of the Coefficient of Expansion of Oxygen: Edward W. Morley and Dayton C. Miller.

The method employed is a differential one, in which two globes, both filled with hydrogen, are connected to a differential manometer, and the difference of pressure of the gas in the two globes is measured at zero and at one hundred degrees, the manometer being at a constant temperature. Oxygen is then put in one of the globes, and by means of the differential manometer the expansion of the oxygen is compared with that of the hydrogen which previously filled the *same* globe. A value obtained some time ago was not final, since the glass of the globes would not endure repeated exposure to steam.

With the present apparatus, a value has been secured which is not subject to much uncertainty. The coefficient of expansion of hydrogen as determined by the *Bureau International des Poids et Mésures* being 0.00366,254, the value of the authors for the coefficient of expansion of oxygen is 0.00367,00.

The Isolation and Properties of Some Electro-Positive Radicals: C. A. Kraus. (By title.)

On the Solubility and Specific Rotatory Power of Carbohydrates and Various Organic Acids and Bases in Pyridine and Other Solvents: J. G. Holty.

Pyridine, the solvent chiefly used in the

experiments, dissolves most of the substances studied except starch and some of the dextrins. Its effect upon their specific rotatory power is marked, decreasing it in some cases and increasing it in others. Rock candy in particles of various assorted sizes gave, with pyridine, solutions of the same concentration.

On the Relation between the Electrolytic Conduction, Specific Inductive Capacity, and Chemical Activity of Certain Liquids: J. H. MATHEWS.

From a study of the dielectric constants of various solvents, as alkyl silicates, mustard oils, pyridine, carbon tetrachloride, etc., and also of solutions made with the same, the conclusion is drawn that this value can not be considered an additive one. Certain acids dissolved in the mustard oils give non-conducting solutions, though retaining their acid characteristics, and alkaloids and amines also yield non-conducting solutions. Addition of water to a solution of trichloracetic acid in benzene produces, up to one tenth of a per cent., very little increase in the conductivity. The work is regarded as an argument against a relation between chemical action and electrolytic phenomena.

Dineric Equilibria: W. D. BANCROFT.

The Proximate Composition and Physical Structure of Trinidad Asphalt: CLIFFORD RICHARDSON.

The material, amounting to six per cent. or over, that remains undetermined in the ordinary proximate analysis is found to consist of volatilized inorganic salt, water of hydration from the clay, and absorbed bitumen. A complete analysis is as follows:

	Crude Asphalt.	Crude Asphalt Dried.
Water and gas	29.0%	......
Bitumen soluble in hot chloroform	39.7	56.0%
Bitumen adsorbed by clay	.7	1.0
Mineral matter on ignition with tricalcium phosphate	27.3	38.5
Water of hydration in clay	3.3	4.5
	100.0	100.0

The mineral matter is the residue from the disintegration of granitic rock and consists largely of clay. The hydrocarbons and nitrogen compounds correspond to those found in California petroleum.

Studies on Phosphate Absorption by Soils: OSWALD SCHREINER.

The author is studying the absorption of phosphates by different soil types, obtaining a curve of absorption and then continuing the work by washing out the absorbed phosphates when a maximum absorption has taken place, thus obtaining the washing-out curve. He finds that the absorption curve is much steeper than the washing-out curve and that the absorbed phosphates are washed out much more slowly than they are absorbed, yielding solutions which are very nearly constant in phosphate content, in the case of any given soil type. Both the absorption curve and washing-out curve are different for different soil types and appear to be characteristic of the type. The absorbed phosphates are readily removed by electrolysis in porous cells.

Laboratory Methods for Studying the Formation of 'Alkali': F. K. CAMERON.

An account of methods used in the chemical laboratory of the Bureau of Soils for studying the formation, movement and accumulation of the different types of 'alkali' found in soils in the arid regions of the west.

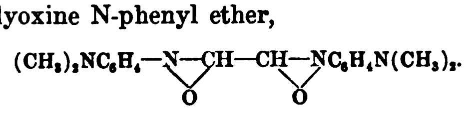
Electro Double Refraction: HOWARD L. BLACKWELL.

The Action of Ethylene Dibromide on p-Nitrosodialkylanilines, II.: HENRY A. TORREY.

When ethylene dibromide and *p*-nitrosodimethylaniline are heated together at 80°–90°, the following reaction occurs:

$$4C_6H_4N(CH_3)_2NO + C_2H_4Br_2 = [C_6H_4(NO)N(CH_3)_2]C_2H_2 + 2C_6H_4(NO)N(CH_3)_2HBr.$$

That is, the hydrobromide of nitrosodimethylaniline and a base formed from the union of two molecules of dimethylaniline and the acetylene group are produced. The base is proved to be tetramethyldiamidoglyoxine N-phenyl ether,



The reaction can best be interpreted by the assumption of the formation of an intermediate addition product, from which hydrobromic acid splits off easily. Diethylaniline gives an analogous reaction.

On the Preparation of Various Acyl Derivatives of Dimethyl 4-Amino-o-phthalate: M. T. Bogert and R. R. Renshaw.

On Some Nitro and Amino Derivatives of Fluorescein (preliminary notice): M. T. Bogert and R. G. Wright.

Researches on Pyrimidines: On 2, 5-Diamino-6-oxypyrimidine: Treat B. Johnson.

The True Benzaldehyde-azo-benzoic Acids: Frederick J. Alway.

The Neutral Sulphite Method for Determining Aldehydes in Essential Oils: S. S. Sadtler.

The Detection and Determination of Ethyl and Methyl Alcohols in Mixtures by the Immersion Refractometer: Albert E. Leach and Hermann C. Lythgoe.

The strongest commercial ethyl alcohol (91 per cent. absolute alcohol by weight) gives a reading with this instrument of 98.3° at 20° C., while the reading of methyl alcohol of 91 per cent. strength by weight is 14.9°. Fifty per cent. ethyl alcohol by weight has a reading of 90.3°, while the same strength (50 per cent.) of methyl alcohol reads 39.8°, all readings being made at 20° C.

The detection of wood alcohol by this method is simple and consists in submitting to refraction the distillate which one makes for the determination of ethyl alcohol in the regular manner in beverages, essences, tinctures, extracts or whatever may be the nature of the samples to be examined. If the refraction of the liquid shows the percentage of alcohol agreeing with that obtained from the specific gravity in the regular manner, it may safely be assumed that no methyl alcohol is present. If there is an appreciable amount of methyl alcohol, the low refraction will indicate the fact.

Not only can methyl alcohol be thus readily detected, but the amount may be determined, since addition of methyl to ethyl alcohol decreases the refraction in direct proportion to the amount present.

A Comparison of Methods for the Determination of Fusel Oil: E. M. Chace and W. L. Dubois.

The general scope of the paper is limited to the description and comparison of the Roese and Allen-Marquardt methods, no satisfactory results having been obtained by the colorimetric method. The basis of the Allen-Marquardt method is the separation of the higher alcohols by extraction from brine with carbon tetrachloride, their oxidation to the corresponding volatile acids by acid bichromate solution and their final titration after distillation. It is regarded by the authors of the paper as long and tedious, but more accurate than the Roese method.

A Crucible Method for the Determination of Sulphur, Halogens and Phosphorus in Organic Substances: S. S. Sadtler.

Methods for Examinations of Cellulose Nitrate and Smokeless Powders: Albert P. Sy.

For purposes of classification and naming it is proposed to divide cellulose nitrates (as the nitration products of cellulose are correctly called) into two classes, ether-alcohol soluble, and ether-alcohol insoluble. Each product in each of these classes is then designated according to its nitrogen content expressed in percentage of dry material. After a brief description of cellulose nitrate manufacture, the methods for examination were summarized as follows: (1) Stability tests: potassium-iodide-starch test, German 135° C. test, ordnance department 115° C. test. (2) Analysis: moisture, nitrogen, soluble (ether-alcohol), insoluble (ether-alcohol), soluble in acetone, cellulose, ash, alkalis. (3) Physical examination: compression test, microscopical tests.

Camphoroxalic Acid Derivatives: J. BISHOP TINGLE and WILLIAM E. HOFFMAN, JR.

The condensed formulæ $AgHC_4O_4C_8H_{14}$, $CuC_4O_4C_8H_{14}$ and $Fe(HC_4O_4C_8H_{14})_3$ represent three types of metallic salts prepared. With amines representatives of four types of compounds have been prepared and their properties and constitution studied; there is also a fifth class the constitution of which is uncertain. The amines from which the above-mentioned compounds were prepared were: α-naphthylamine, β-naphthylamine, *p*-toluidine, *m*-toluidine, benzylamine, diethylamine, dimethylamine, methylamine, *o*-phenylenediamine, benzidine, nitrotoluidine, semicarbazine, benzamidine, phenylhydrazine. Certain other amines gave negative or unsatisfactory results.

Rosocyanine: C. LORING JACKSON and LATHAM CLARKE.

Rosocyanine has the same percentage composition as curcumine. Its relation to curcumine was discussed.

The Formula of Curcumine: C. LORING JACKSON and LATHAM CLARKE.

The older formula $C_{14}H_{14}O_4$ is shown to be in harmony with the analyses and is supported by a determination of the molecular weight.

The Reduction of 5-Nitro-4-ketodihydroquinazolines to the Corresponding Aminoquinazolines, and the Preparation of Certain Derivatives of the Latter: M. T. BOGERT and V. J. CHAMBERS.

The Synthesis of 5-Nitro-4-ketodihydroquinazolines from 6-Nitroacetanthranil and Primary Amines: M. T. BOGERT and H. A. SEIL.

On Isomeric O and N Ethers Derived from 2-Alkyl-4-oxy-5-nitroquinazolines and 2-Alkyl-4-keto-5-nitrodihydroquinazolines: M. T. BOGERT and H. A. SEIL.

Some Acyl Derivatives of Homoanthranilic Nitrile and the 7-Methyl-4-ketodihydroquinazolines Prepared Therefrom: M. T. BOGERT and A. HOFFMAN.

The Condensation of Succinylosuccinic Acid Diethyl Ester with Guanidine: A Derivative of 1, 3, 6, 8-Naphtotetrazine, a New Heterocycle: M. T. BOGERT and A. W. DOX.

The Methoxyl Group in Certain Lignocelluloses: ALVIN S. WHEELER.

Influence of Dilution and of the Presence of Lactose and Maltose upon the Osazone Test for Glucose: H. C. SHERMAN and R. H. WILLIAMS.

Some Further Notes on the Possible Existence of Esters of Fulminic Acid: H. C. BIDDLE.

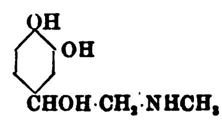
Some Condensation Products of 1-Phenylnaphthalene-2,3-dicarboxylic Anhydride: NORMAN A. DUBOIS.

On Monobromalkylketodihydroquinazolines: W. F. HAND and M. T. BOGERT.

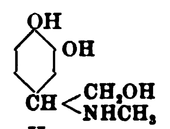
Some New Salts of the Nitrosulphobenzoic Acids: Edward Hart.

Adrenalin, the Active Principle of the Suprarenal Gland: T. B. Aldrich.

The formula $C_9H_{13}NO_3$, first proposed by the author, has been confirmed by various investigators. The structure, several details of which are certain, is possibly represented by one of the two following formulæ:



I.



II.

Compounds synthetically prepared on the lines of formula I. seem to be similar physiologically to adrenalin, but recent work by the author gives like evidence for II. The work is being continued.

The Efficiency of Copper Foil in Destroying Certain Bacteria in Water: W. H. Buhiig.

Several sets of experiments, made along the lines suggested by the recent work of Moore, show that at incubator temperature the typhoid bacillus disappears in a few hours in the presence of copper, but at room temperature, in hydrant water, it persists several days. In the case of the colon bacillus the copper treatment has little practical value, but the dysentery bacillus appears to yield quickly.

Colloidal Suspensions and their Relations to Problems in Water Purification: J. W. Ellms and J. F. Snell.

Turbid water show many of the properties of colloidal suspensions, *e. g.*, the Tyndall effect, migration of the turbidity under the influence of the electric current, coagulation by electrolytes, etc. A possible explanation of the mechanism of coagulation by sulphates of aluminum and iron is the formation of positively charged colloidal hydrates, which precipitate the negatively charged colloidal particles in the water. Experiments are in progress on the relative concentrations of colloidal suspensions and electrolytes required for precipitation and the influence of substances in retarding the coagulation.

The Composition of Cooked Foods: W. D. Bigelow.

Artificial Digestion Experiments: Edward Gudeman.

As the result of a large series of artificial digestion experiments with pepsin and pancreatin on egg albumen with reference to the interference of preservatives, colors, and condiments, the following conclusions are drawn: (*a*) Preservatives and condiments do not interfere with peptic and pancreatic artificial digestion when in the proportion of 1 part to 400 or less, in acid medium. (*b*) Acid preservatives and condiments increase the factor of digestibility in neutral medium. (*c*) In alkaline medium the results are abnormal, retarding the action of ferments. (*d*) Colors, irrespective of source or origin, whether animal, vegetable, mineral or synthetic, do not affect artificial digestion when used in quantities of 1 part or less to 400 parts of the food products. (*e*) Vegetable and synthetic colors are directly digested in the same proportions by pepsin and pancreatin and the actual food value of both classes is the same.

Notes on Occurrence of Pentosans in Second Pressing Cider: J. A. Le Clerc and L. M. Tolman.

Color Tests for Cod-liver Oil: W. D. Bigelow.

The Presence of Hexone Bases in Bacteria: Mary F. Leach.

Dried and pulverized bacteria belonging to the colon group were digested with thirty-three and one third per cent. sulphuric acid for several hours, until the pro-

teid was all decomposed. From the extract thus obtained, lysine was separated as picrate, and the picrate transposed into the chloride. Both salts were identical with the corresponding salts of lysine prepared from gelatin and from fibrin. Thus the presence of a hexone base in the bacterial cell has been established, and one more point of resemblance has been found between bacterial and other proteid.

The Testing of Wheat Flour for Commercial Purposes: HARRY SNYDER.

The points noted or discussed were: the lack of adequate standards for commercial testing of flour; the difficulty of adopting tests suitable to all types of flour; the influence of total proteids on size of loaf and commercial grade; the application and value of gliadin nitrogen determinations; the value of the ash results in determining the grade of a flour or in detecting the mixing of grades; the value of color in determining the commercial grade of a flour, and the influence of the bleaching of flours; and the relation of high bread-making value to nutritive value.

The joint use of baking and chemical tests was recommended. The chemical tests can determine the grade, as patent, straight or clear, while the baking tests can determine the bread-making value of the sample.

The Occurrence of Extractives in Apple Peel: H. C. GORE.

The Pectocelluloses of the Apple: W. D. BIGELOW and H. C. GORE.

The Analysis of Sugar Mixtures: C. A. BROWNE, JR. (By title.)

Chemical Preservatives Used in Food Products. Are They Harmful? E. W. DUCKWALL.

Attention was drawn to the difference between the effect of substances on the growth of bacteria and their effect on the action of digestive ferments.

Experiments have shown that salicylic and benzoic acids in strong solution do not impede peptic digestion more than other substances in a mixed diet, and that the feeding of these preservatives to guinea pigs and rabbits has no action on their growth or organs. It should be noted, however, that the duration of the trial was rather short, while the number of individual tests was small.

Recent Work on Columbium and Tantalum: R. D. HALL.

On the Oxidation of Hydrazine: A. W. BROWNE.

When a solution of hydrazine sulphate is treated with hydrogen peroxide, potassium chlorate, potassium persulphate, ammonium metavanadate or lead dioxide in acid solution, hydronitric acid is formed in very appreciable quantities.

In acid solution potassium permanganate and potassium dichromate oxidize hydrazine sulphate, forming in some cases a trace of hydronitric acid, in others, none at all.

Certain other oxidizing agents, including potassium iodate, bromine water and red lead, yield no hydronitric acid whatever.

The principal reaction involved in the oxidation of hydrazine sulphate is expressed by the equation:

$$N_2H_4 + 2O = N_2 + 2H_2O.$$

The equation for the reaction in which hydronitric acid is formed may be written

$$3N_2H_4 + 5O = 2HN_3 + 5H_2O.$$

The two reactions appear to take place simultaneously.

In the light of this work it is apparent that when an oxidizing agent is to be used in the quantitative determination of hydrazine, or when hydrazine sulphate is to be used in the quantitative determination of an oxidizing agent, care must be taken to

choose materials and arrange conditions, if possible, so that no hydronitric acid shall be formed.

The error introduced by the formation of a given amount of hydronitric acid will obviously be greater if the analysis consist in the measurement of the nitrogen gas evolved than if it consist in the determination of the unused excess of the oxidizing agent.

The Chemical Separation of the Radioactive Types of Matter in Thorium Compounds: HERMAN SCHLUNDT and RICHARD B. MOORE.

REPORTS FROM INSTITUTIONS.

This valuable feature was continued, thirteen institutions responding. It should be borne in mind that the following extremely condensed summaries of the reports of work in progress during the past year are, in most cases, far from exhaustive.

University of Pennsylvania.—Electrodeposition of lead and mercury from salts and metals, with the use of a rotating anode; also, deposition of cadmium from an ammonia solution, gold from cyanide solution, etc. Methods for complete analysis of alkali halides, etc., with the use of a mercury cathode and silver anode. Investigation of the compounds of columbium and tantalum.

Massachusetts Institute of Technology.—Electrical conductivity of aqueous solutions at high temperatures. Conductivity of fused salts. Ionization of the successive hydrogens of polybasic acids, as phosphoric, sulphuric and hydrogen sulphide. System of qualitative analysis including the rare elements (now completed in outline with the exception of the rare earth group). Separation of electropositive groups and study of the properties of the metal-ammoniums.

University of Wisconsin.—(In addition to work elsewhere reported on at this meeting.) Dielectric constants of oleic acid, oleates, etc. Difference of electrical potential between electrodes of the peroxides of lead and manganese and various solutions. Study of alloys of tin with zinc and with cadmium. Improved static method for measuring vapor tensions of solutions. Equilibrium in the system silver nitrate-pyridine. Numerous experiments on osmosis, the details of which will soon be published.

Johns Hopkins University.—Composition of hydrates formed in aqueous solutions by various electrolytes. Temperature coefficients of conductivity of various electrolytes. Condition of electrolytes in mixed solvents. Electrical method for the combustion of organic compounds. Osmotic pressure of cane sugar solutions. Electrolytic production of pure caustic alkalies. Rate of oxidation of various aromatic compounds by potassium permanganate. Chlorides of orthosulphobenzoic acid. Camphoroxalic acid derivatives. Pinacone-pinacoline rearrangement.

Harvard University.—Study of tetrabrom and of tetrachlor-orthoquinone. Bromine addition products of dimethylaniline. Atomic weights of sodium, cadmium, iodine and other elements. Compressibilities of elements and simple compounds. Electromotive effects; electrostenolysis. Action of potassium iodide on bromanil and chloranil. Action of phenyl hydrazine on various quinones. Action of ethylene dibromide on *p*-nitrosodialkylanilines. Oxidation of organic compounds by air in presence of catalyzers. Determination of phosphoric acid. Preparation of pure nitrogen on a large scale.

Lafayette College.—Salts of *m*- and *o*-nitroparasulphobenzoic acids. Salts of *m*-sulphonitrobenzoic acid. Constitution

of talc. Purification of titanic acid. Some non-aqueous concentration cells.

Ohio State University.—Synthesis of ortho-oxyazo compounds. Action of phosphoric and related acids in the production of esters. Gibbs's method for precipitating magnesium ammonium phosphate. Separation of calcium and magnesium. Apparatus for determining moisture in samples. Electrolytic separation of bismuth.

University of Chicago.—Dissociation phenomena in the sugar group. Constitution of dibromacetylidene. The various forms of liquids and amorphous sulphur. Catalytic action. Stereoisomeric nitrogen derivatives. Radioactivity of uranium compounds. Affinity constants of dibasic acids. The chlorides of manganese. Phenylmalonic nitrile.

Verbal reports were also made by representatives of Cornell University, University of Toronto, University of North Carolina, Columbia University, and the New York Testing Laboratory.

The local committee, of which John C. Miller was chairman, made ample provision for the entertainment of the society, and their services and those of the Buffalo Society of Natural Sciences (in whose rooms the chemical meetings were held), as well as the courtesies of several other local organizations, were recognized in a rising vote of thanks. Carriages were provided on Thursday afternoon for a drive about the city, and many members visited the Gratwick Research Laboratory, where a paper was presented entitled, 'On the Chemical Composition of a Series of Mouse Tumors,' by G. H. A. Clowes and W. S. Frisbie.

The chemical plants both in Buffalo and in Niagara Falls refused admittance, but Mr. Francis A. J. Fitzgerald delivered an interesting address on 'The Electrochemical Industries of Niagara Falls.' The subject was treated from an evolutionary point of view, and the effects of the struggle for existence and the influence of environment considered. In the Hall process for making aluminium the raw material bauxite is now purified by an electric furnace process, and the carbon electrodes baked in an electric furnace. The severe competition brought on in the abrasives market by carborundum has stimulated the production of other artificial abrasives such as 'alundum,' an artificial corundum made by fusing bauxite in the electric furnace. The production of artificial graphite was developed by the demand for graphite electrodes in the electrolytic processes for the production of chlorine, caustic soda, etc. While the problem of making nitric acid from the air has not yet reached the commercial stage, the spark discharge is used industrially for the production of ozonized air for the production of vanillin from oil of cloves. The manufacture of chlorine and caustic alkalies has grown greatly in the last ten years, consequently competition is severe and results in the invention of processes using chlorine gas for the manufacture of carbon tetrachloride, tin tetrachloride, etc. Seeking an outlet for sodium and sodium peroxide, the makers are putting new commercial products on the market, such as 'oxone' a fused form of sodium peroxide which generates oxygen when put in water, and various compounds such as magnesium peroxide, calcium peroxide, zinc peroxide and sodium perborate. Samples of many of the products mentioned in the address were exhibited, and oxygen was generated from oxone by a simple apparatus.

This address was given at the Iroquois Hotel, the headquarters of the meeting, and was followed by an informal luncheon served with the compliments of the hotel.

On Friday afternoon a large number of members availed themselves of a boat trip in the harbor on the city fire tugs, while others visited the soap plant of the Larkin Company. In the evening about eighty attended a subscription dinner at the Hotel Iroquois.

The whole of Saturday was devoted to an excursion to Niagara Falls. A visit to the Power House was followed by a luncheon given by the Natural Food Company, and this by a trip over the Gorge Route.

The total registration at the meeting was 178. The secretary, Dr. W. A. Noyes, announced that as the result of a mail vote with reference to the establishment of an abstract journal in cooperation with the Chemical Society of London and the Society of Chemical Industry, seventy-nine adverse votes had been cast out of a total of about 700 so far received. Four eminent scientists were elected honorary members of the society: Svanté Arrhenius, Walther Nernst, H. W. B. Roozeboom and Julius Thomsen.

The next meeting will be held at New Orleans, December 29 to January 1, 1905–6.

AUSTIN M. PATTERSON.

SCIENTIFIC BOOKS.

A System of Metaphysics. By GEORGE STUART FULLERTON. New York, The Macmillan Company, 1904. Pp. x + 627. Price, $4.

Professor Fullerton makes in the work before us a very creditable attempt to be true to the promise of his title-page; he constantly bears in mind that he has set himself not merely to produce a series of essays on metaphysical subjects, but to set forth the whole scheme of his science in a complete and orderly manner. Only a reader who, like the present reviewer, has himself had occasion to do the same thing can fully appreciate the difficulties of such a task and the recognition fairly due to even a partially successful execution of it. Under Mr. Fullerton's hands the subject falls into four main divisions: Part I., 'The Content of Consciousness,' starting from the standpoint, assumed by the author to be that of psychology, of a world of experiences primarily given as states of the individual consciousness, aims at showing the unsatisfactory nature of such a general conception of the real, and the need for some more fundamental metaphysical interpretation of experience. Part II. discusses the 'external world' in a series of chapters devoted mainly to the doctrine of space and time, and concluding with a rather perfunctory defense of the conception of existence as a perfect mechanism against the 'descriptive' view of mechanical science championed by Kirchhof, Mach, James Ward and others. Part III., 'Mind and Matter,' deals at length, and with much acuteness, with the problem of the relation of mind and body, and contains, besides a very vigorous and damaging attack upon the subjective idealism which denies the reality of any knowledge of things as distinct from our own mental states, Professor Fullerton's own ingenious version of the doctrine of psychophysical parallelism. Finally in Part IV., 'Other Minds and the Realm of Minds,' the author deals with the traditional problems of the old rational psychology and natural theology. Speaking summarily, it may be said that Professor Fullerton's position in metaphysics is that of a critical realist. He holds, that is, that there is a real physical world of extra-mental objects, and that of that world we have a direct, and not merely a symbolic or representative, perception. Further, he maintains that the whole world of minds and bodies alike forms a complete and perfect mechanism, the relation between the bodily and mental aspects of it being a purely logical 'parallelism,' and consequently adopts a purely determinist view of moral action. Finally he so far follows in the footsteps of Kant as to regard the existence of God and the reality of a future life as matters beyond the limits of demonstrative science, but as affording scope for a legitimate exercise of faith.

It is hardly to be expected that the execution of so extensive a work should be equally

satisfactory in all its parts, and, speaking for myself, I can not but think the last two divisions of the book much superior to the two which precede them. The reason for the difference in value seems to be that the author is much more at home in the psychological problems with which these sections mainly deal than in the realm of pure logic and epistemology. Indeed, the very presence of Part I. might, perhaps, be regarded as an unfortunate mistake. The conception of the experienced world as consisting of 'states of consciousness' is not only in itself an absurdity, as Professor Fullerton himself shows conclusively, and not without humor, in the chapters of Part III. which deal with the doctrines of Clifford and Karl Pearson, but is an absurdity not likely to be entertained by the student except as the result of misguidance at the hands of a psychologizing metaphysician. Hence it seems a pity to start the reader off on a false scent for the purpose of afterwards demonstrating his error to him. Surely it would have been better to make a beginning with the 'naïve realism' which is habitual to all of us in our every-day life, and to assume from the first as a working hypothesis that we have a direct perception of objects which, whatever their nature, are to be carefully distinguished from the processes by which they are cognized.

The author's second part is, perhaps, the least satisfactory portion of the whole work. Mr. Fullerton is apparently quite unfamiliar with the indispensable foundation of any satisfactory doctrine of space and time, viz., the modern mathematical theory of infinity and continuity. Hence his attack upon the Kantian 'Aesthetik' inevitably becomes a very grave *ignoratio elenchi*. The real objection to the 'Aesthetik' is, of course, that no analysis of mathematical concepts can be adequate which fails to recognize that their application to space and time is logically a secondary affair, and requires to be preceded by the logical investigation of relations of number and order considered in complete abstraction from the special nature of the terms numbered and ordered. This fundamental point is ignored by the author, who prefers to furbish up old difficulties about motion which may puzzle the non-mathematical reader, but will be seen at once by those acquainted with the mere outlines of modern investigations into infinity and continuity to be idle fallacies, and that of a kind which, if sustained at all, must be fatal not merely to the special theories of Kant, but to the whole spatial and temporal scheme of mathematical physics. Mr. Fullerton himself attempts to find a way out of his own self-created difficulties by adopting Berkeley's analysis of space and time as perceived by the senses, but with the mental reservation that the space and time which are conditions of the existence of the real extra-mental world are just what the mathematical physicist declares them to be. He forgets that according to Berkeley there is no extra-mental world and, therefore, no such 'real' space or time, and that according to himself the infinitely divisible and continuous space and time of the physicist are full of logical contradictions and must, therefore, be purely unreal.

Even in the latter half of the work the writer does not seem to be by any means as successful on the constructive as on the destructive side. Thus, ingenious as his defense of 'parallelism' is, he nowhere seems to have given any more cogent reason for adopting a parallelistic rather than an interactionist position than the obvious reflection that interaction is inconsistent with a purely mechanical interpretation of the universe. But that any science really demands our acceptance of absolute mechanism as the truth about things is a statement which he makes no attempt to prove, nor does he show any real comprehension of the meaning of anti-mechanistic philosophers, or of the gravity of the difficulties which have to be faced by a relentless and consistent theory of pure mechanism. A reader who should take his notions on the subject from Mr. Fullerton's fifteenth chapter would, indeed, probably go away with the notion that Dr. Ward (and? Mach) is an unscientific and credulous person who thinks that after all there is 'nothing in' modern

mechanical science. There is, in fact, nothing that I for one desiderate more in Professor Fullerton's metaphysical structure than a serious and thorough discussion of the question, what are the real logical postulates of mechanical science, as distinguished from the mechanistic philosophy professed by some, but by no means all, men of science, and how far those postulates imply the belief that the actual course of any real process is through-and-through mechanical.

But the adequate discussion of this problem presupposes a much more searching critical analysis of the logical character of knowledge than Professor Fullerton has seen fit to undertake. One very important issue which such an analysis would raise would be the question whether an empirical realism, such as that successfully upheld by Professor Fullerton against the subjective idealist, does not admit, or possibly even demand, as its complement a further doctrine of critical or transcendental idealism.

A. E. TAYLOR.

SOCIETIES AND ACADEMIES.

THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

THE last regular meeting of the New York Section of the American Chemical Society was held in the Assembly Hall of the Chemists' Club, 108 West 55th St., Friday, June 9, at 8:15 P.M. The chairman, Dr. Wm. J. Schieffelin, presided.

The reports of the secretary and treasurer for the year 1904–1905 were read and approved. The secretary's report showed a net gain in membership of the section of sixteen.

The program of the evening was as follows:

Some Condensation Products of 1 Phenyl-naphthalene-2-3-Dicarboxylic Anhydride: NORMAN A. DU BOIS.

It was shown by Michael and Bucher that acetic anhydride and phenylpropiolic acid act upon each other to form a new compound, α phenylnaphthalene-dicarboxylic anhydride. The reaction is said to be practically quantitative. In preparing quantities of this compound for experimentation, a modification in the usual method for the preparation of phenylpropiolic acid was discovered by the writer. Formerly it was prepared from cinnamic acid by esterifying and brominating, and then boiling the cinnamic ethyl ester dibromide with alcoholic potash for eight hours. It was found that this long boiling was unnecessary and that as good a yield was obtained if the alcohol was distilled off immediately after dissolving the cinnamic ethyl ester dibromide.

The α phenyl-naphthalene-dicarboxylic anhydride can be condensed with resorcin in the presence of zinc chloride, to form a compound analogous to fluorescein. This fluorescein analogue, when treated with the theoretical quantity of bromine in glacial acetic acid forms a tetra bromo substitution product, analogous to eosin. Both of these compounds are direct dyes for animal fibers. The fluorescent analogue also forms iodine and chlorine substitution products.

The α phenyl-naphthalene-dicarboxylic anhydride can also be condensed with most other phenols to form condensation products analogous to those formed by phthalic anhydride.

On the Preparation of Hydrobromic and Hydriodic Acids: L. H. FRIEDBURG.

Bromine is allowed to trickle into paraffin which is kept in a molten condition by placing the flask containing it in a shallow steam-bath. The bromine vapors which will pass over along with the hydrobromic acid, are partly absorbed by a second paraffin-containing flask, joined to the first and standing together with it in the water-bath.

The fact that iodine and paraffin, or better still, iodine and vaseline, will allow the production of hydriodic acid was a further novelty. Here the gas produced is not washed but simply passed through a big empty bulb-tube before allowing it to be absorbed by water.

Præseodymium Tetroxide: CHARLES BASKERVILLE and J. B. THORPE.

That which has been regarded as the tetroxide, Pr_2O_4, is a brownish-black substance resembling manganese dioxide in appearance and conduct with hydrochloric acid. It should rather be called the dioxide. By fusing this dioxide with sodium dioxide a yellow-

ish substance has been obtained which on analysis shows the formula $Pr_2O_4 \cdot H_2O$. This tetroxide is insoluble in water, but readily decomposed by acids, giving the normal salts of præseodymium.

On the Simplicity of Præseodymium: CHARLES BASKERVILLE and G. M. MACNIDER.

Unsuccessful efforts were made to fraction præseodymium by fractional precipitation at different temperatures with oxalic acid, fusion with sodium dioxide, fractional solution of the dioxide and tetroxide in hydrochloric acid. The fractionation was followed by an examination of solutions of uniform strength, acidity and amount by means of a Zeiss comparison spectrometer.

Artificial Willemite: CHARLES BASKERVILLE and A. BOURGOUGNON.

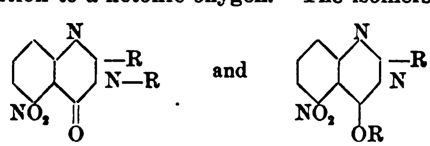
Artificial zinc ortho-silicate made of pure material neither fluoresces nor phosphoresces under the influence of the ultra-violet light. On the introduction of small amounts of manganese, bismuth and thorium various results were obtained. All of these bodies are phosphorescent; only that one containing the manganese is fluorescent.

The Production of Boron Carbide from Boric Oxide in the Electric Furnace: H. J. BLISS and S. A. TUCKER.

The extreme hardness of this substance might give it certain uses as an abrasive. The authors showed that it could be prepared directly from boric acid and coke in large quantities, whereas hitherto boron has been used for the preparation. The existence of Muplhauser's BC was shown to be extremely doubtful and is probably a mixture of graphite and B_6C.

Isomeric Ethers in the Qinazoline Group: H. A. SEIL and M. T. BOGERT.

The isomerism in this group depends on the migration of an imide hydrogen in the ortho position to a ketonic oxygen. The isomers are



The first was prepared by the action of NH_2R on the 6-nitro-acyl-anthranil. The second by heating the alkyl-hydrogen-quinazoline with potassium hydroxide and alkyl iodide in a bomb tube to 150° C. Both are crystalline solids soluble in hot alcohol. The ether melts at ten degrees lower than its isomeric quinazoline.

Acyl Derivatives of 4 Amino-methyl-phthalate: R. R. RENSHAW and M. T. BOGERT.

4 Amino-methyl-phthalate is readily obtained by the reduction of 4-nitro-methyl-phthalate. It crystallizes from alcohol and benzine in glistening plates. Acyl derivatives of this were prepared with mono and dibasic fatty acids, aromatic acids and substituted carbonic acids. These substances are well-defined, crystalline bodies, soluble in most organic solvents, nearly insoluble in water, ligrome and petroleum ethers.

The following officers were then elected for the year 1905–1906:

President—F. D. Dodge.
Vice-President—A. A. Breneman.
Secretary-Treasurer—F. H. Pough.
Executive Committee—Wm. J. Schieffelin, H. C. Sherman, Charles Baskerville and G. C. Stone.

F. H. POUGH,
Secretary.

DISCUSSION AND CORRESPONDENCE.

ON THE SPELLING OF 'CLON.'

IT is over two years[1] since Mr. H. J. Webber first proposed the word *clon* as the designation of horticultural groups of plants which are propagated exclusively by vegetative means. During this period of probation, as it were, the need for such a word has been amply demonstrated, and its formal adoption by the Association of Agricultural Colleges and Experiment Stations has placed it within the cognizance of lexicographers. No other word apparently exists which can properly be extended in meaning to cover the idea expressed by *clon;* and the purpose of the present writer is merely to suggest an improvement in orthography which seems to be demanded by both phonetic and philological considerations. One of the few definite indications of quantity in

[1] SCIENCE, N. S., **18**: 501–503, 1903.

English words is found in the final *e*, which always denotes the long sound of the preceding vowel, as in *tone, bite, hate,* etc. It is true that recent writers on botany have frequently attempted to simplify the spelling of technical terms to the detriment of phonetic principles, and so we have such forms as *mestom, plerom, hadrom,* etc., which must be admitted to our dictionaries as variants of the infinitely preferable *mestome, plerome, hadrome,* still employed by careful writers. The fact that there are two Greek words κλών and κλόνος (the latter giving us the English adjective *clonic*) merely emphasizes the importance of properly indicating the long *o* in English derivatives of κλών. I therefore suggest *clone* (plural *clones*) as the correct form of the word to be adopted in dictionaries, lexicons and general writings. It is to be hoped that the 'shackles of philology' to which Mr. Webber so feelingly refers will not prevent him from accepting this suggestion in the friendly spirit in which it is offered.

Charles Louis Pollard.
Springfield, Mass.

SPECIAL ARTICLES.

PRELIMINARY NOTE ON THE ARAUCARINEÆ.

In my paper on the megaspore-membrane of the Gymnosperms[1] a footnote refers to the occurrence of supernumerary nuclei in the pollen-tube of *Agathis*. Recently I have found that the number of nuclei in the pollen-tube of *Araucaria* may be even greater than that observed in the former genus, being over thirty in number in one instance at least. The supernumerary nuclei are placed fore and aft of the generative group in a parietal stratum of protoplasm not unlike that of the megaspore. Again the behavior of the pollen-tube in *Araucaria* is peculiar. The pollen-grains do not fall into the micropyle but are found at the distal end of the ligule more or less entangled in its serrated edge. From this point the tubes pass in grooves on the surface of the ligule or the scale, a distance of an inch or more, to the micropyle, which they enter and after penetrating the long beak of the nucellus arrive at the archegonia. This method of pollination and growth of the pollen-tube is unique among the Gymnosperms so far as is known and its bearing on the problems of fertilization important—notably on what may for convenience be termed the 'free-growth' theory of chalazogamy.

The double nature of the integument is very apparent in young ovules of *Agathis*, as Strasburger[2] long ago observed. The micropyle in some cases at least extends almost to the base of the nucellus on its upper surface, though usually not so far on the lower, in the form of V-shaped slits.

The archegonia are peculiar in structure arrangement and development. Their study is throwing new light on the character and relationship of these organs in the subgroups of the Conifers.

The vascular supply to the ovules worked out by series of celloidin sections is found to be different from the descriptions already given of it and promises very material aid in settling the vexed question of the primitive or specialized nature of the subgroup under consideration.

These features and other chiefly anatomical ones, added to the peculiarities presented by the megaspore-membrane and the tapetum, as described in the paper to which reference has been made above, place the Araucarineæ in a very isolated position among the subgroups of the Coniferæ. The forthcoming monograph, it is hoped, will make this clear and aid materially in the establishment of the phylogenetic position of the Araucarineæ.

Robert Boyd Thomson.
Biological Department,
University of Toronto,
June 20, 1905.

[1] 'The Megaspore-Membrane of the Gymnosperms,' by R. B. Thomson. University of Toronto Studies, Biological Series, No. 4, pp. 85–146, Pls. I.–V. 1905.

[2] Strasburger, E., 'Die Angiospermen und die Gymnospermen,' p. 91, 1879.

THE DEATH (?) OF AN AMŒBA.

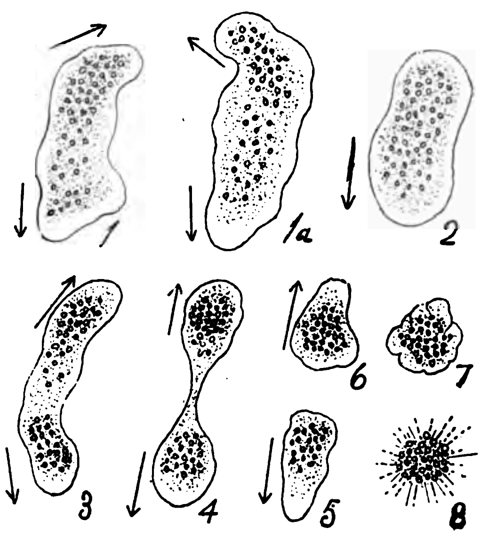
While watching some amœbæ on February 8 I observed one which was behaving in a singular manner. Instead of progressing in

one direction this one appeared to be in a state of indecision. One end, which for convenience I shall call the anterior, was consistently trying to go in one direction. At the other end there was in progress an active formation of pseudopodia and an apparent endeavor to move in the opposite direction. The parenchyma of the amœba contained a rather larger amount of granular material than usual, and this was a little more abundant towards the posterior end.

The formation of pseudopodia at the posterior end was first in one direction (Fig. 1), and then in another (Fig. 1, *a*). This was accompanied by simultaneous formation of pseudopodia at the anterior end. The intracellular struggle which then ensued, during which the granular protoplasm flowed from the central region into both posterior and anterior pseudopodia, would continue for a few seconds, to be followed by the retraction of the pseudopodia and a few seconds of quiet. At last (Fig. 3), after two or three such trials, there appeared to ensue a determined struggle between the opposing ends of the animal. Soon the central portion became narrow and thread-like (Fig. 4). This connecting bond at last broke, and it was then seen that the animal had divided into two approximately equal parts. The part which had been the posterior region contained more than half of the coarse granules. The new individuals moved away from each other in opposite directions, each following the direction of its previous efforts. The one that had been the anterior end of the undivided animal not only contained fewer granules than the other, but it also had a larger proportion of clear protoplasm at its anterior end. It behaved normally and quickly moved out of the field. The other (Fig. 6), after moving in a normal manner for a few seconds, ceased to form pseudopodia, and assumed an irregularly spherical shape (Fig. 7).

Up to this point I supposed I had been witnessing an ordinary case of division. Then occurred what looked like the dissolution of this bit of supposedly immortal living substance. The ectosarc and protoplasm disappeared suddenly as if by a disruptive explosion, the larger globular granules remaining as an inert mass (Fig. 8).

It would appear that the posterior half of the original animal was too heavily charged with granular bodies. The ruptured surface probably failed to heal over. Rapid osmosis



Sketches of a dividing amœba made from memory a few minutes after the events which they illustrate had been observed. 1, 1*a*, pseudopodia at opposite ends of the animal with energetic flow of the endosarc in opposite directions; 2, cessation of struggle, movement in only one direction; 3, renewal of struggle with elongation of animal; 4, beginning of division; 5 and 6, division completed, 5 normal, 6 abnormal new amœba; 7, position assumed by 6 a few seconds later; 8, spontaneous disruption of 7. No nucleus was seen.

took place. The dense protoplasm increased in bulk rapidly until the ectosarc, no longer able to resist the pressure from within, gave way suddenly.

There was sufficient vegetable debris present to keep the specimen from being crushed by the cover-glass.

No signs of life could be seen in the disintegrated part. It was simply a cluster of granules with no coherence and no connecting material.

The length of the undivided animal was about 0.03 millimeter. Several other amœbæ

of the same size and appearance were observed in the culture, but none were seen behaving in an abnormal way. As I did not realize that I had been witnessing anything unusual until the final catastrophe, the time occupied by the division and the subsequent events up to the disruption of the short-lived half was not noted. The whole operation lasted but a short time, probably little longer than one minute.

EDWIN LINTON.

HOMING OF FISSURELLA AND SIPHONARIA.

The *Patella* is the only mollusc whose homing powers have been investigated. *Fissurella*, a rhipidoglossate prosobranch, and *Siphonaria*, which stands on the border line between the opisthobranchs and the pulmonates, while differing more or less widely from *Patella* in structure, closely resembles it in the form of the shell and in their littoral habits. It was, therefore, an interesting question whether they resemble it also in the possession of the homing power. A stay at the Bermuda biological station in the summer of 1903 gave an opportunity to answer this question, although a few days only being available for the investigation, it was by no means as complete as could be wished. Such as it is, however, I present it for the benefit of future students of the subject.

The specimens studied were *Siphonaria alternata* Say and *Fissurella barbadensis* Gmelin.[1] Both are abundant at Bermuda, where they live clinging to the exposed faces of the bare rocks between tide marks. Bare rocks, I say, for to a New England eye one of the most striking features of the Bermuda coast is the entire absence of the larger algæ, which upon our own rocky shores shelter so large and varied a fauna. The rocks are calcareous, soft and of irregular surface and the home of *Siphonaria* is recognizable by a greenish spot where the foot has rested. That of *Fissurella*, as my notes show, is also clearly marked, though I have carelessly omitted to note how it may be known. Both species, as will be seen from the following notes, exhibit undoubted though limited homing powers.

[1] These specimens were kindly identified for me by Mr. Charles W. Johnson of Boston.

In marking animals and scars Higgins's water-proof ink was used. White paint, which was used by Davis, was not accessible, but as the ink marks last about three days they are fairly satisfactory. *Siphonaria*, being comparatively small, was readily removed from its scar; *Fissurella* I was seldom able to detach uninjured, and, accordingly, my observations upon this species were limited almost entirely to watching its voluntary departures and returns. As might be anticipated, the animals, unlike *Patella*, remain motionless on their scars during low tide, moving, if at all, only when the incoming water has moistened and cooled their immediate surroundings.

Siphonarias did not home when removed to a distance of more than six inches and were most likely to return when removed not more than two inches. A quiet and shallow tide-pool furnished the most favorable conditions for their return. If the animal, on being transferred, was set down with its head away from the scar, it turned in the proper direction and, so far as I could judge, those headed away were quite as likely to get back as those headed toward the scars. In general, animals which lost their way seemed to crawl restlessly about for two or three days; each time one was visited it was found in a new place. One, however, settled down at once in a new home and at the end of the third day had made a discolored spot. On being transferred to his old home he apparently failed to recognize it and immediately crawled away. Usually the scar was recognized at once by a returning wanderer, and on reaching its edge he would turn about, if necessary, so that his shell might fit the scar, would slip on to it and settle down. *Siphonaria alternata* thus appears to have a sense of direction, the ability to recognize its own recently-left scar, and the power of homing when removed not more than six inches.

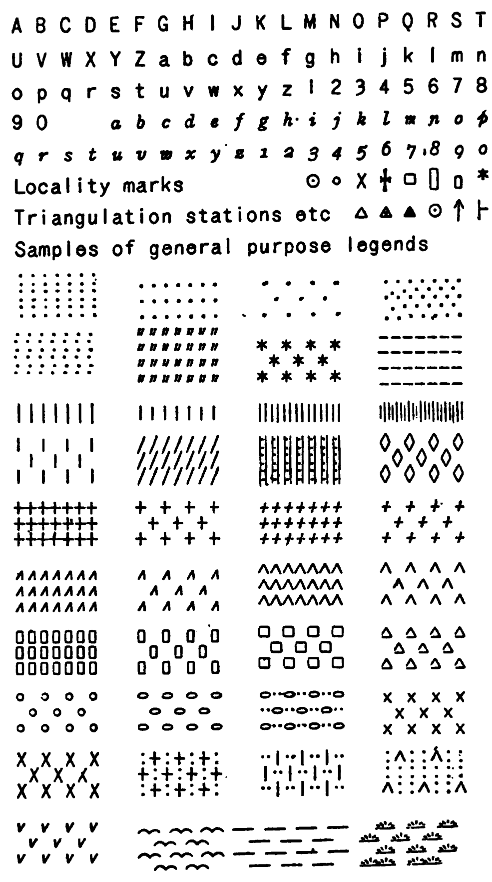
Experiments with *Fissurella*, as I have said, were usually unsuccessful. That these molluscs have the power of homing is seen, however, by watching them. As soon as the tide has so covered him that he is not exposed to the wash of the waves a *Fissurella* is very

likely to start on a brief journey, going only about two inches from the edge of his scar, and returning to settle upon it again, sometimes within fifteen minutes from the time of his leaving it. In no experiment did I find a *Fissurella* homing if he had been removed more than three inches, though one which had been removed six and a half inches was nearly half way back in twenty-four hours. My departure from Bermuda prevented my learning his final fate. *Fissurella,* like *Siphonaria,* recognizes his scar and orients himself properly with reference to it as soon as he reaches it. In one instance I found a scar occupied by two animals; one was the owner, who had evidently returned from his wanderings to find that a usurper had already taken possession of half of his home. He had, however, crawled on to as much of the scar as was still unoccupied and the next day was in sole possession, while the intruder had disappeared. *Fissurella barbadensis,* then, undertakes short voluntary excursions and returns to his scar, but his power of homing when removed by some one else has not been fully tested. M. A. WILLCOX.

MACHINE-MADE LINE DRAWINGS FOR THE ILLUSTRATION OF SCIENTIFIC PAPERS.

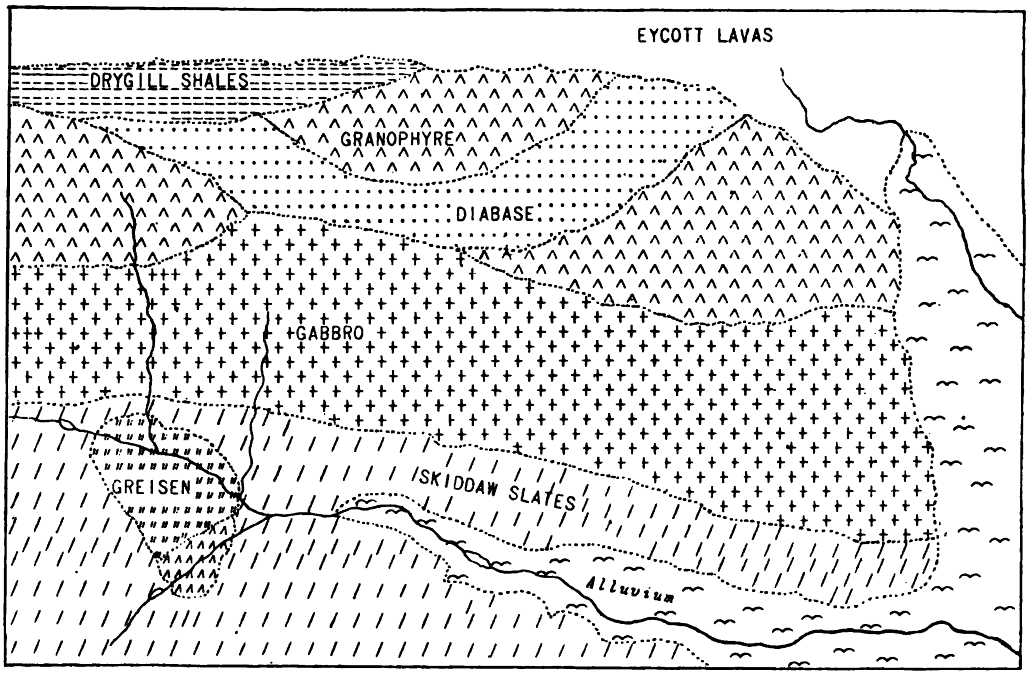
IT is safe to say that the majority of persons who from time to time publish scientific papers are seriously hampered in the preparation of text illustrations by the difficulty and expense entailed in the tedious drawing of map, section or diagram. Comparatively few authors can command the services of skilled draughtsmen or have themselves the requisite training to produce satisfactory line drawings. Yet the desirability of greatly increasing the proportion of such illustration in the thousands of scientific articles published each year is manifest. That clearness, precision and conciseness in the exposition of a theme are generally enhanced by the use of abundant, appropriate diagrams is as evident as that the blackboard is the constant friend of the teacher of any branch of natural history or philosophy; the printed page needs its blackboard.

Ideally, the author should himself be able to make the original drawing quickly, neatly and artistically. The usual execution of drawing with the pen is, to the average author, discouragingly slow and expensive, not always neat, and still less often artistic. The following note relates to some experiments made to increase rapidity and neatness in the production of line drawings by the use of a machine. At the outset the experiments were,



for obvious reasons, planned without any idea of rivaling the artistic work of the pen in a skilled hand. The aim has been to secure economy of time in execution and clear-cut precision of legend for the drawing. In both these respects enough success has been attained to warrant the recommendation of the machine method to geologists, geographers and others who desire to prepare useful text

illustrations at a minimum cost of labor. Some essays of the kind were made and published in the *Bulletin* of the Museum of Comparative Zoology at Harvard College, Vol. XXXVIII., 1902, Pls. 11, 12 and 13, in the *Amer. Jour. of Science,* August, 1903, pp. 118 and 120, and in the *American Geologist,* August, 1903, p. 66. The machine there used was an ordinary Underwood typewriter easily and quickly applied cross-hatchings, etc., made with an ordinary drawing pen. In complex diagrams free-hand work may generally be expected to supplement the work of the machine. The subject of each diagram should thus be studied with the end of securing suitable contrasts of legend along with the maximum economy of pen work; yet some pen work is almost always necessary.



fitted with a black record silk ribbon. Recently the Hammond Typewriter Company of New York has constructed, from the writer's specifications, a typewriter provided with a carbon ribbon and with ninety special characters designed for the preparation of line drawings to accompany geological and geographical papers. The same machine can be similarly used for statistical, engineering and other diagrams of a more or less mechanical and simple composition. Of course, this method should not wholly replace the use of the pen even, for example, in the differentiation of areas in a geological map or section. The ultra mechanical look of the typewritten legend can often be pleasingly relieved by the

The typewriter has its most general application in lettering, that most difficult element in line drawings. The particular machine made by the Hammond Company has the advantage of making it possible to employ a great range of type styles. Using the carbon ribbon, the writer has found that any one of the one hundred and twenty-five shuttles made for the machine (each shuttle bearing ninety characters and including the lettering for one of twenty-six different languages), will give an impression suitable for photographic reproduction. Each shuttle can be placed in the machine ready for work in a few seconds. The shuttles now on the market cost $2.50 each and any new character can be supplied

by the company at the cost of fifty cents. The ordinary Hammond machine furnished with a back-spacing key can be used for manuscript diagrams up to about eight inches in diameter, but the machine No. 6, fitted with a sixteen-inch roll, permits of the preparation of diagrams fourteen inches in diameter. The usual silk ribbon gives a 'woolly' line and is far less satisfactory than the carbon ribbon. A highly calendered and high grade linen paper of medium to heavy weight, or a thin Bristol board may be recommended. Often more than one impression of the key is necessary to obtain the required depth of tint for photography; such repeated impressions can be made at great speed by employing the back-spacing key. Care must be taken not to smudge the carbon of the completed printing.

The accompanying cuts serve to show something of the method as applied to geological diagrams. The diagram of alphabets and legends has been reduced to three fourths of its original diameters. The legends are intended to represent a few examples of those possible with the machine. They can be indefinitely increased in number and varied in design by the engraving of new characters on the shuttle and by using various permutations and combinations of the existing characters. The map is reduced to two thirds of its original diameters. It was copied from Harker's sketch map of the Carrock Fell District, published in the *Quarterly Journal of the Geological Society of London,* Vol. 51, 1895, Pl. IV. Here the geological formations could have been yet more clearly differentiated by cross-hatching with the ruling pen for one of them, but this particular drawing was made to illustrate the neatness and clearness of the machine-made production rather than to illustrate an ideal diagram. So far as the typewritten part of the 'drawings' is concerned, the use of the machine in preparing these illustrations represents a saving of from seventy-five to ninety per cent. of the time required by a draughtsman to duplicate the 'drawing.'

R. A DALY.

INTERNATIONAL BOUNDARY COMMISSION,
OTTAWA, CAN.

MEETING OF THE BRITISH ASSOCIATION IN SOUTH AFRICA.[1]

THE arrangements for the forthcoming meeting of the British Association in South Africa have now been completed, and Mr. Silva White, the assistant secretary of the association, sailed for Cape Town in the *Walmer Castle,* on Saturday last, July 1. The number of members who will proceed to South Africa to attend the meeting is 385, and of these no less than 276 members have intimated their intention to visit the Victoria Falls at the conclusion of the ordinary work of the association. The official party, consisting of leading representatives of science and guests of the association, with the general and sectional officers for this meeting and the president, numbers 140 in all, and will sail by the *Saxon* on July 29. Most of the other members will proceed to the meeting by the *Durham Castle* and the *Kildonan Castle,* both of which sail on July 22.

There will be receptions and social functions, excursions, etc., at Cape Town, Durham, Pietermaritzburg, Johannesburg, Kimberley and Bulawayo. The central organizing committee for South Africa (chairman, Sir David Gill, K.C.B., F.R.S., hon. secretary, Dr. Gilchrist) has carried out the coordinating work of the program. The lists of local committees and subcommittees contain nearly one thousand names, from which it may be concluded that much interest is taken in the meeting.

Lectures of a popular character will be delivered at the chief towns visited. These lectures have now been definitely arranged as follows:

Cape Town: 'W. J. Burchell's Discoveries in South Africa,' Professor Poulton; 'Some Surface Actions of Fluids,' Mr. C. V. Boys. *Durban:* 'Mountains: the Highest Himalaya,' Mr. D. Freshfield. *Pietermaritzburg:* 'Sleeping-sickness,' Colonel D. Bruce. *Johannesburg:* 'Distribution of Power,' Professor Ayrton; 'Steel as an Igneous Rock,' Professor Arnold. *Pretoria:* 'Fly-borne Diseases, Malaria, Sleeping-sickness, etc.,' Mr. A. E. Shipley. *Bloemfontein:* 'The Milky Way and the Clouds of Magellan,' Mr. A. R. Hinks.

[1] From *Nature.*

Kimberley: 'Diamonds,' Sir William Crookes; 'Bearing of Engineering on Mining,' Professor Porter. *Bulawayo:* 'Zimbabwe,' Mr. Randall-MacIver.

The president's address to the association will be delivered at Cape Town, on August 15, and at Johannesburg, on August 30. Mr. G. W. Lamplugh's report on the geology of the Victoria Falls will take the form of an afternoon address to Section C at Johannesburg.

SCIENTIFIC NOTES AND NEWS.

THE American Medical Association met last week in Portland, Ore., with an attendance of about 1,500 members. Dr. Louis S. McMurtrie, of Louisville, Ky., delivered the presidential address, taking as his subject 'The American Medical Association, its Origin, Progress and Purpose.'

M. CURIE has been elected a member of the Paris Academy of Sciences.

DR. ADOLF WULLNER, of Aachen, has been made an honorary doctor of engineering by the Technical Institute of Dantzig.

M. COMBES, recently premier of France, has returned to the practise of medicine in his native village.

THE steamship *Roosevelt,* which will carry Commander R. E. Peary to the Arctic regions, sailed from New York City on July 16.

PROFESSOR W. M. DAVIS, of Harvard University, sailed from New York, July 15, for England, to accompany the British Association to South Africa. The party will leave Southampton on July 29, and return in mid-October.

THE DE MORGAN medal of the London Mathematical Society has been awarded to Dr. H. F. Baker, F.R.S.

THE Bissett-Hawkins gold medal of the Royal College of Physicians has been presented to Sir Patrick Manson for the services he has rendered to science and humanity by his researches on tropical diseases.

THE Senn medal of the American Medical Association for an essay on some surgical topic has been awarded to Dr. John L. Yates, of Chicago.

THE British Meteorological Office, which corresponds to our Weather Bureau, has been reorganized, and placed under the charge of a committee. The appropriations for the service is £15,300, and the salary of the director is £1,000. The committee is as follows: Mr. W. N. Shaw, Sc.D., F.R.S., director; Captain Arthur M. Field, R.N., hydrographer to the navy; Captain A. J. G. Chalmers, professional officer of the Marine Department, Board of Trade; Mr. W. Somerville, Sc.D., assistant secretary of the Board of Agriculture and Fisheries; Professor G. H. Darwin, F.R.S., University of Cambridge; Professor Arthur Schuster, F.R.S., University of Manchester; Mr. G. L. Barstow, nominated by the Treasury.

AMONG those who are the recipients of the king's birthday honors *Nature* notices the following: Lord Rayleigh, O.M., F.R.S., has been made a privy councilor; knighthoods have been conferred upon Professor T. McCall Anderson, of the University of Glasgow; Mr. E. W. Brabrook, C.B., formerly registrar of Friendly Societies; Dr. A. B. W. Kennedy, F.R.S., emeritus professor of engineering and mechanical technology at University College, London, and president of the admiralty committee on machinery designs; Dr. Boverton Redwood; and Dr. W. J. Smyly, president of the Royal College of Physicians, Ireland. Colonel D. Bruce, F.R.S., has been made a Knight Commander of the Bath. Dr. W. T. Prout, principal medical officer, colony of Sierra Leone, and Dr. J. W. Robertson, late commissioner of agriculture and dairying of the Dominion of Canda, have been made C.M.G.'s. The honor of Knight Bachelor has been conferred upon Dr. E. S. Stevenson, member of the medical council of the Cape of Good Hope; and Mr. Philip Watts, F.R.S., director of naval construction, is made an ordinary member of the civil division of the second division, or Knight Commander, of the Order of the Bath.

STUDENTS of Sibley College, Cornell University, have ordered designs made for a bronze tablet, which they will erect in memory of the late Dr. R. H. Thurston, formerly director of the college. The tablet is being designed

by Professor H. S. Gutsall, of the College of Architecture, and will be erected in a stone niche of the new Thurston Hall of Engineering, now in process of construction.

A BUST of the electrical inventor, Charles J. Van Depoele, has been placed in the Lynn Public Library.

MR. ROLLO APPLEYARD has presented to the Royal Institution a portrait of the late Professor J. D. Everett, the physicist.

DR. EDWARD STICKNEY WOOD, since 1876 professor of chemistry in the Harvard Medical School, died on July 11, at the age of fifty-nine years.

DR. J. M. CUNNINGHAM, formerly surgeon-general of India, has died at the age of seventy-one years.

DR. HERMANN VON WISSMANN, the African explorer, has died at the age of fifty-one years.

PROFESSOR HERMANN NOTHNAGEL, professor of clinical medicine in Berlin, and an eminent authority on the subject, died on July 7, at the age of sixty-four years.

PROFESSOR VON MILULICZ, professor of surgery at Breslau, and surgeon-general of the Prussian army, died on June 14.

PROFESSOR JACQUES ELISÉE RECLUS, professor of geography at the new University of Brussels, has died at the age of eighty-five years.

THE U. S. National Museum is about to receive a large collection of South American moths, the gift of Mr. Wm. Schaus, of Twickenham, England, and New York. This is one of the finest collections from this region extant, containing some 60,000 specimens and hundreds of types, mostly the result of Mr. Schaus's personal collecting.

THE west pavilion of the stone building, known during the Louisiana Purchase Exposition as the Palace of Fine Arts, was formally opened on July 1 to the public as the St. Louis Museum, embracing in the thirty-six rooms, collections of exhibits from forty different countries, valued collectively at $500,000.

WE learn from the *Electrical World* that the United Engineering Building Committee voted a contract last week for $795,000 to the Wells Brothers Company, of New York City, for the construction of the new building under the Carnegie gift, on West Thirty-ninth Street, New York. This contract does not include anything for electrical plant, wiring, steam heating, etc., but deals solely with the construction of the edifice. The lots have already been excavated, and work will begin without delay. October, 1906, is spoken of as the time of completion and readiness.

DEARBORN OBSERVATORY at Northwestern University was damaged by fire on July 15 to the extent of $1,000. None of the instruments was harmed.

THE Bureau of Forestry, to which the control of the national forest reserves have been transferred, will hereafter be known as the forest service.

IT is stated in the *Electrical World* that a conference has been called by the Reichsanstalt as a preliminary to the meeting of the International Commission on Electrical Units and Standards. To this conference the Reichsanstalt has invited the heads of bureaus in America, England, Belgium, Austria-Hungary, also Lord Rayleigh, Professors Kohlrausch, M. Mascart and Carhart, of the University of Michigan. The conference will be held in Berlin, probably the latter part of October, the exact date not having as yet been fixed. It seems probable that the commission will be called together within the next two years.

AT a meeting of a number of members of Parliament on July 4, the following resolution was unanimously passed: "That this meeting, being satisfied of the necessity of further state aid to the National Physical Laboratory, at Teddington, as regards both equipment and maintenance, requests the chairman and conveners of this meeting to prepare and present a memorial to the chancellor of the Exchequer asking for such additional aid, and that the memorial be signed by members here present or who, being absent, may be in sympathy with its objects."

THE University of Colorado, at Boulder, has been able to acquire, through the gener-

osity of Hon. Simon Guggenheim, of Denver, a large collection of birds' eggs and nests gathered by the late Dennis Gale, of Boulder. The collection embraces eggs of nearly all the species known in the vicinity of the university, and in many cases there are specimens taken from nests at six or more different altitudes. The collection also contains many nests from the sub-alpine and alpine districts which are seldom found in museums.

UNIVERSITY AND EDUCATIONAL NEWS.

The temporary building occupied by the veterinary department of the University of Pennsylvania was destroyed by fire on July 6, entailing a loss of upward of $10,000. The university authorities are about to construct a building for the veterinary department at a cost of $200,000.

The University of Illinois has organized a School of Education, the purpose of which is to provide for special preparation of three classes of workers in the public school system, namely, first, the high school teacher, including the high school principal; second, the supervisor of special subjects, such as manual training, domestic science, music, drawing and physical training, and third, the school superintendent. The director of the school is Dr. Edwin Grant Dexter, and the faculty includes thirty-one instructors of various academic ranks. Besides this, the five normal school presidents of the state, together with Hon. Alfred Bayliss, state superintendent of public instruction, constitute a board of special lecturers, who, during the year, will discuss at the university topics of educational interest.

The University of Southern California, at Los Angeles, has begun the erection of a two-story north wing and a similar south wing to the building used by the College of Liberal Arts. The improvements will cost about $50,000. The north wing will be devoted mainly to the biological sciences. It will add 110 feet of north light to the present laboratories and comprises a zoological laboratory, 45 x 34 ft.; a laboratory for physiology and bacteriology, 46 x 26 ft., and a botanical laboratory, 45 x 30 ft. Besides these there will be a special laboratory 16 x 13 ft., an office, and a lecture room with a seating capacity of 200. Apparatus costing about $2,000 will be added to the present equipment. The south wing will be equipped in a similar manner for the departments of chemistry and physics.

The daily papers state that Attorney-General Mayer has decided to bring an action to deprive Cornell University of 30,000 acres of timber land between Tupper and Upper Saranac Lakes, in the Adirondacks. He will endeavor also to break a contract whereby Cornell has permitted the Brooklyn Cooperage Company to cut timber on the tract. This tract was purchased by Cornell with $165,000 out of an appropriation of $500,000 made by the legislature of 1898 for a forestry experiment, to last thirty years. Governor Odell in 1903 declined to permit any more money to go out for the experiment, and that came to an end.

Dr. Nicholas Senn has been elected professor of surgery in the University of Chicago.

Professor H. B. Dates, dean of the engineering school of the University of Colorado, has accepted a professorship of electrical engineering at the Case School of Applied Sciences.

Mr. Charles Brooks, assistant in botany in the University of Missouri, has been appointed instructor in botany in the College of Agriculture of New Hampshire.

Dr. William I. Chamberlain, president of the Arcot Mission College in India, has accepted the chair of logic and mental philosophy in Rugers College.

Miss Ann Rebecca Torrence, for the past two years assistant in botany in Wellesley College, has been appointed supervisor of the fifth and sixth grades and teacher of nature study in the State Normal School, New Paltz, New York.

Dr. Eugen Grandmougin has been appointed professor of chemistry in the Polytechnic Institute of Zurich in the room of Professor E. Bamberger, who has retired, owing to ill-health.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, JULY 28, 1905.

CONTENTS.

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE AMERICAN MEDICAL ASSOCIATION: ITS ORIGIN, PROGRESS AND PURPOSE.[1]

BOTH established usage and the by-laws of this association require the presiding officer to deliver annually an address touching such matters as he may deem of importance. In the early years of the association the president's address was devoted to an epitome of the progress of medical science in its various departments during the preceding year. Since distinguished orators are now selected annually to perform this important service, the president's address may be more appropriately directed to subjects relating to the general welfare of the profession and to the purposes for which this great organization was established.

The annual session of the American Medical Association is always an occasion of special moment and universal interest to the medical profession of America. That several thousand physicians from all sections of our broad country assemble annually for the advancement of medical science and the elevation of our profession is a splendid testimonial to the earnestness of professional achievement and aspiration. The occasion can not but command the respect of all who are concerned in the progress of science and the betterment of the human race. The spirit which pervades such an assemblage is the desire for improvement, for the increase of scientific re-

[1] President's address, at the fifty-sixth annual session of the American Medical Association at Portland, Oregon, July 11–14, 1905. From *The Journal of the American Medical Association.*

sources, and for the diffusion of medical knowledge. Closely related to these ennobling purposes is that social instinct of our profession, which would elevate and be elevated by interchange of views resulting from common experiences, and by mingling together in pleasant friendly intercourse. Happily our present meeting is held under ideal conditions for the exercise of all the functions of such an organization. Perfect harmony prevails. The differences which at times have divided us have all been satisfactorily adjusted; and we are today as one man in our united effort to advance the science of medicine, to enlarge the scope of its beneficence and to promote the welfare of our profession.

Since our meeting at Atlantic City one year ago, many of our members have ceased their labors and passed to the great beyond. The list is a long one. Among the number is that of Nathan Smith Davis. He was one of the founders of this association, an ex-president; a member of the board of trustees, the first editor of the *Journal*, and for years a power for good in its affairs. He lived beyond the time allotted by the psalmist, and all his years were filled with labor and with honor. I will not undertake at this time to estimate adequately his great services, or appropriately to pay tribute to his memory. This will be done later in the session by one better prepared than I to eulogize our departed leader.

At our last session, Dr. B. C. Pennington, of Atlantic City, was chairman of the committee of arrangements. He was honored with the fourth vice-presidency in recognition of his ability, his high professional standing, and his devoted services to this association. His name, too, is now found among the year's honored dead. A cultured gentleman, a learned and accomplished physician, his memory will ever remain as an inspiration for high ideals and noble endeavor.

EARLY YEARS.

When the American Medical Association was organized in 1846 it is doubtful if there were more than 25,000 physicians in the entire United States of America. It was organized as a representative body, composed of delegates from affiliated societies, colleges and hospitals throughout the states. It was a body of delegates from all state, district, county and other medical societies which adopted the code of ethics of the national association. The apportionment of delegates was on a basis of one for every ten members of the societies represented. For a number of years the delegate body thus constituted was not too large for the discussion of important subjects and the ready transaction of business.

With the rapid increase in population, the admission of new states to the union, and the settlement of new territories, came a vast increase of physicians, with a corresponding multiplication of state and county societies. Without change in the apportionment of delegates, the national association developed into a body too large and unwieldy for the transaction of business. Indeed, during the latter years under the original system of organization, practically every member in attendance on the annual sessions was a delegate. While the work of the sections was carried on with increasing excellence, the important functions relating to legislative and other matters, belonging to a great national organization of the medical profession, were neglected. The general sessions brought together hundreds of delegates, forming a convention so large that thorough discussion of important questions and judicious action on the same became practically impossible. Moreover, the delegates attending the annual sessions

constituted a body annually changing in personnel; and the sources of attendance changed with the sections of the country in which the meetings were held. In consequence there could be neither that equal representation of all sections which must obtain in a national body, nor continuation of work from year to year along definite lines.

THE SECTIONS.

During these early years it was the steady improvement in the work of the sections which drew the best element of the profession to the annual sessions. Many leaders of the profession in the various states attended the sections in which they were interested, and took no part in the proceedings of the general meetings. The sections have now reached such a high degree of efficiency that they have attained the standard so much desired, and rank as leading special national societies in the several departments of medical science which they represent.

As chairman of the committee on sections and section work, I have carefully studied the workings of the sections. As a result of this experience, I would repeat the recommendation of my distinguished predecessor in this chair, that the secretary of each section should be elected for a term of years. No national society can maintain its efficiency which changes its secretary annually. And again, I would suggest that the officers of the several sections meet together in conference as soon as practicable after the adjournment of the session at which they are elected, in order that definite plans may be formulated for the scientific work of the next annual session. The conference of section officers in New York last November contributed much toward the development of the admirable scientific program now before you for the present session.

It should be the aim and purpose of every member of this association to aid the officers of the sections in elevating continually the standard of scientific work. Every American physician may have pride in the work done year after year in the sections of this association.

THE JOURNAL.

It would be a difficult task were we to undertake a definite estimate of the influence of the *Journal* in the great work which this association has accomplished during the past two decades. When it was decided to discontinue the annual volume of transactions, and to establish a weekly journal, the change was viewed with apprehension by many. The influence of this publication, the property of the association, in stimulating research, diffusing knowledge, elevating professional thought and conduct, and building up this great organization can not be computed. This part of my discourse is so replete with suggestion, that I fear the time and space at my command will not permit such consideration as should be devoted to it.

The volumes of the *Journal* mark the steady and continued growth of the association, and likewise bear testimony to the fact that the *Journal* itself has been a potent factor in that growth. Under the judicious direction of the board of trustees the *Journal* has steadily advanced as a scientific publication. By the untiring daily services of the present able editor, it has leaped into the very front rank of scientific publications, and in all that a great weekly medical journal should be it has no superior in the world. The power exerted by such a publication as a medium of communication among the members of the association is inestimable, to say nothing of the other more important functions performed by a great weekly journal. It has been

the most potent instrument in building up this association to its present proud position as the largest medical organization in the world. No other American medical periodical has a circulation so distinctly national, and no other journal can sustain the same relation to the great body of the medical profession. It is a great engine whose power is constantly increasing, constantly extending. With such increased power comes increased responsibility, much of which rests with the house of delegates in the selection of proper men to fill the responsible places of the trustees. No other office should be regarded higher in honor than that of the trustees, as no other affords greater scope for unselfish labor and efficient service to the association. Under the conditions of our organization more power is invested in this board than the combined power of all other officers.

THE NEW ERA.

At the annual session of 1900 a committee on reorganization was appointed, and one year later, at St. Paul, the report of the committee was submitted and adopted. It included a new constitution, which altered the basis of apportionment for delegates, so as to reduce the delegate body to 150, and definitely established a close relationship between the national organization and the state, district and county societies. For the first time a practical scheme of complete organization of the medical profession of the United States was provided. This is the fourth annual session held under the new plan of organization.

Previous to the reorganization, the valuable scientific work of the sections constituted almost the sum total of the effective work accomplished by the association. Matters appertaining to medical education, to the public health, to national legislation and to the welfare of the profession received no deliberate consideration; and in consequence no decisive action was carried out. This condition existed for the reasons already mentioned. In a word, the very objects and aims for which the association was organized were thwarted by the growth of the association into an unwieldy delegate body. Under the reorganization, the house of delegates, in which the membership of the state societies is proportionately represented, now gives deliberate consideration to those important matters, already indicated, which under the former organization were neglected.

The influence of the revised plan of organization was immediately apparent in the increased attendance at the annual sessions, and the stimulus felt in every purpose of the association. And each year this influence has grown, until some idea can now be formed of the great possibilities to come from organization on a definite and practical plan. The good results which accrue to the profession as a whole, and to every member as an individual, are so positive that no subject can deserve more careful consideration by this body than that of medical organization. Indeed, it is the fundamental question before us, and on its decision depend the results of all our other efforts in all directions.

In order that we may thoroughly appreciate the origin and purpose of the association, and thereby be better prepared to meet its present and future requirements, I have very imperfectly outlined the history of its earlier years. During the more than half century of its existence it has always brought to its councils the ablest and best men in the profession of America. Among its leaders from the beginning are found the most eminent physicians and surgeons of the day. In the list of its active members are the names of Samuel D. Gross, Paul F. Eve, Austin Flint, Marion Sims,

N. S. Davis, Alfred Stillé, Lewis A. Sayre and many others which adorn the annals of American medicine. It has from the beginning been a great power with the profession of America. Its greatest influence, as I have already indicated, was in the growth and diffusion of scientific knowledge through the splendid work of the sections. In elevating medical education, in promoting legislation and advancing the powers of public health organizations, its influence was most felt in the development of a helpful public professional opinion. The extension of the influence and advantages of organization to the masses of the profession was gradually lost sight of in the annual meetings, and the work relating to matters of public policy was spasmodically considered and imperfectly executed. Whatever was accomplished along these lines worthy of mention was the work of committees. The necessity of reorganization was appreciated by the leading members of the association long before it was accomplished. In 1888, Dr. N. S. Davis, as chairman of a committee appointed for the purpose, reported a scheme of reorganization very similar to that adopted in 1901 at St. Paul.

ORGANIZATION.

The object of this association shall be to federate into one compact organization the medical profession of the United States, for the purpose of fostering the growth and diffusion of medical knowledge, of promoting friendly intercourse among American physicians, of safeguarding the material interests of the medical profession, of elevating the standard of medical education, of securing the enactment and enforcement of medical laws, of enlightening and directing public opinion in regard to the broad problems of state medicine, and of representing to the world the practical accomplishments of scientific medicine. (Article II., constitution of the American Medical Association.)

If every physician worked alone, relied on his own unaided observation for his knowledge, never looking outside his own scope of view, ignorance would prevail and there would be no progress in medical science. Medicine is not an exact science, and until perfected by extorting from nature all her secrets, it must from the nature of things continue to be a progressive science. Never before in the history of medicine has such marked progress in all its departments been made as during the present age. Theories have been supplanted by facts; laboratory research and clinical investigation have taken the place of tradition and authoritative opinion. To rely on the accomplishments of the college period is to be left behind in hopeless incompetency. The advance of medical knowledge is to be observed first in our medical societies, and afterward in our scientific medical journals. In the medical societies innovations are subjected to criticism and discussion by those competent to judge the merits of scientific contributions. Moreover, there is a stimulus to study and investigation from association with workers in the same field; and one obtains a broader view of every subject so considered. The physician, more than any other professional man, is isolated by the conditions of his life, and to no profession is the educating influence of society work so essential and invaluable. This same condition of isolation is at the foundation, for the most part, of the jealousies and petty bickerings so prevalent in our profession. These troubles are, as a rule, the result of misunderstandings, and are both prevented and corrected by coming together in a society composed of physicians. The lonely worker in any calling is prone to become narrow, suspicious and morbid. Our medical societies are the great post-graduate schools of the profession, where knowledge is increased and individual character developed.

But the promotion of scientific investiga-

tion, and the diffusion of medical knowledge are not the only objects of organization. Our profession has a most essential and important duty in relation to the public health. Through no other agency can municipal, state and national health authorities formulate and secure recognition of laws to prevent and control disease. Another duty no less essential is so to regulate and to control medical education that the ignorant and unworthy shall not be admitted to the privileges of the profession, thereby preserving the time-honored standard of professional honor and scientific capability. In this age of organization, without it the profession is powerless to secure the enactment of humane sanitary laws, by which alone the people can be protected from preventable diseases. The welfare of the profession collectively and individually can only be subserved by organization. Without such organization, our profession, as a body politic, will be without unanimity of sentiment or action in relation to the important scientific, ethical and social questions which confront us; and consequently without influence politically, socially or otherwise.

In the declaration of the constitution adopted at St. Paul, which I have just quoted, the American Medical Association has undertaken to place within reach of every reputable medical practitioner in the United States these incalculable advantages of medical organization.

The committee on reorganization appointed in 1900 has treated this subject in a masterly manner. After a careful study of the condition of the profession throughout the states with relation to organization, reports have been made to the association showing the needs of the profession and the extent of the work required. A uniform plan of organization for state and county societies, making the county society the unit of organization, and federating all state societies in the national association in harmonious cooperation, has been prepared by the committee. The able chairman of this committee has with remarkable tact, patience, and good judgment given his personal supervision to this great work in almost every state and territory. In his latest report it is announced that all the states and territories, except three, and including Hawaii and Porto Rico, are now organized on a practically uniform plan, with universal local societies, and coincident membership in them and the state associations as the cardinal feature. To illustrate the magnitude of this work, I mention that, under the stimulus of reorganization after the plan of the committee, the Michigan State Medical Association increased in membership in one year from 452 to about 2,100. Texas increased the membership in the same time from 382 to 2,510, while several states quadrupled their membership. While these results are phenomenal, and elicit our admiration, it will be realized how much remains to be done when it is considered that few of the states have over 50 per cent. of the eligible members of the profession enrolled as members of the society. Indeed, the work is yet almost in its infancy. What has been accomplished is an assurance for the future; and considering the brief time since reorganization began, is a high tribute to the enterprise of the national association and the work of its able and efficient committee. The possibilities of this work are stupendous, and as it proceeds the association can confidently undertake the great reforms of such incalculable moment to the profession and the public. In his official report to the house of delegates one year ago, the chairman of the committee on organization, after reporting the splendid results of his labors during the year, said:

The real test of our organization will come in each state when the first out-burst of enthusiasm has passed, and county societies, the foundation for everything, are likely to disappear as rapidly as they have been formed, unless their usefulness to the rank and file of the profession can be demonstrated in a very broad way.

In recognition of this fact, it is of the utmost importance that the personal attention so effectively given to this work throughout the states by the chairman of the committee be continued.

MEDICAL EDUCATION.

When the American Medical Association was founded in May, 1846, the delegates assembled in response to the following preamble and resolutions of the Medical Society of the State of New York:

WHEREAS, It is believed that a national convention would be conducive to the elevation of the standard of medical education in the United States, and

WHEREAS, There is no mode of accomplishing so desirable an object without concert of action on the part of the medical societies, colleges and institutions of all the states, therefore be it

Resolved, That the Medical Society of the State of New York earnestly recommends a national convention of delegates from medical societies and colleges of the whole union, to convene in the City of New York, on the first Tuesday in May, in the year 1846, for the purpose of adopting some concerted action on the subject, set forth in the foregoing preamble.

From this it is apparent that this association was founded with the avowed and specific purpose of elevating the standard of medical education in this country. This subject has constantly received consideration from the association throughout the years of its existence; and while no distinct and positive reform marks its action, the perpetual demand for improvement undoubtedly molded the public sentiment of the profession which ultimately stimulated action on the part of the medical colleges. Since the addresses of my two distinguished predecessors, who immediately preceded me in this chair, were devoted to the consideration of medical education, I shall only make brief allusion to this subject. The several national organizations and the many state boards which are now dealing with this important professional problem invest the changing conditions with peculiar interest. The present is a transition period in the advancement and reform of medical education in America.

The consideration of this subject in the house of delegates culminated in the establishment last year of the council on medical education of the American Medical Association. During the past year the council has taken up its work with exceptional energy and good judgment, and is directing its efforts along most practical lines. The first annual conference was held in Chicago, April 20, last. Representatives of many state examining and licensing boards, of the American and Southern Medical Colleges associations, and of the government medical services, attended and participated in the discussions of the papers presented. The plan and scope of the work of the council can be best appreciated by a consideration of this extract from the address of the distinguished chairman of the council delivered to the conference:

What we need is cooperation, especially the cooperation between the medical profession, represented by the American Medical Association, and the state and county medical societies, and the state authorities, represented by the state licensing and examining boards. The most important question, therefore, before this conference is, How can the American medical profession and the state licensing bodies cooperate to elevate and control medical education? It is believed that such cooperation is possible. In such cooperation it will be the function of the American Medical Association to represent and possibly mold the opinion of the medical profession, and employ its influence and the influence of the county and state medical societies in obtaining proper medical legislation. In such cooperation it will be the function of the

state licensing bodies to protect the interests of the public and the profession by seeing that the medical laws are properly interpreted and enforced, and from their intimate knowledge with the medical acts they can often be of service in securing or modifying medical legislation.

It is not the purpose of the Council on Medical Education of the American Medical Association to attempt to arrogate to itself any special powers, nor does it desire either to criticize or interfere in any way with any of the agencies which are already in the field. If its creation is to result in good, it must be the means of obtaining cooperation between the medical profession, and the medical schools, the colleges of arts, the state examining boards, the government services, and all the factors which are interested in elevating and controlling medical education.

By securing cooperation of the various state and national bodies engage in this important work, recognizing the varied interests involved in the numerous states of the union, and fostering an intelligent public sentiment, so essential for every great reform, the influence of the association will be of the most effective character.

MEDICAL LEGISLATION.

Chapter VII., Section 3, of the by-laws provides a permanent committee on medical legislation 'to represent before congress and elsewhere the wishes of this association regarding any proposed legislation that in any respect bears on the promotion and preservation of the public health, or on the material or moral welfare of the medical profession.' This committee was appointed in 1903, and under the leadership of its accomplished and energetic chairman proceeded at once to organize the auxiliary committee provided in the by-laws. This being a permanent committee, its work will be continued from year to year. With the auxiliary committee, representing every state in the union, and the several medical departments of the government service, every representative of the people in congress can be reached directly. The importance of this work is so apparent that I need only call attention to it at this time, and urge on all members of the association the necessity of aiding and cooperating with the committee at all times. The disregard of the good work of the medical profession in the public service (to say nothing of the indignities offered) on the part of congress is notorious; and it is only by such concentrated power of the profession, intelligently directed, that such injustice may be overcome. I commend to your consideration the report of this committee in order that you may appreciate the important work already projected.

COUNCIL ON PHARMACY AND CHEMISTRY.

The use of proprietary medicines in the treatment of diseases has become one of the most confusing and demoralizing questions of the day. All proprietary medicines must not be classed as secret nostrums, for there are many honestly made and ethically advertised proprietary preparations that have therapeutic value and that deserve the approval of the medical profession. But there are many preparations offered the profession, which are protected by copyright or trade-mark, with formulæ more or less fictitious, and for which are made extravagant claims, which are in fact secret remedies. These preparations are so exploited by the manufacturer that the physician is persuaded to use them instead of writing a prescription; and since they usually bear popular names and plausible therapeutic claims, they appeal to the fancy of the laity. The field is an enticing one for commercial enterprise since these preparations in many instances are simple mixtures and contain the most inexpensive drugs. The use of such remedies is both unscientific and unjust, alike to physician and to patient.

The separation of the legitimate pharma-

ceutical preparations from the class of fraudulent nostrums described is a most difficult undertaking. This perplexing problem forced itself from year to year on the attention of the board of trustees in the effort of the board to keep the advertising pages of the *Journal* free from unethical advertisements. In order to have thorough protection and to make no unjust discrimination, the board has established the council on pharmacy and chemistry to make the necessary investigations. The council is composed of pharmacists and chemists of national and international reputation. It will be the aim of the council to publish in book form, a list of the preparations which are not officinal, yet which conform to the proper ethical standard. The work of the council will be similar to that of the Committee on Revision of the United States Pharmacopeia.

The magnitude and importance of this work is such that I desire to direct attention to it here, and to commend it to the members of the association as deserving every possible aid and advancement. It is the only practical way to deliver the profession from one of the greatest curses that ever came on it.

It has been my endeavor on this occasion to outline the plans of the founders of the association, briefly to trace the evolution of those plans throughout half a century of progress, and to recount some of the purposes that invite our active exertions at the present time. From a small body of delegates our association has increased until it is now the largest medical organization in the world. It owns valuable property, has accumulated a considerable fund, and has a large annual income, all of which belongs to, and is subject to the control of, the members who through their delegates select the board of trustees to manage their funds.

The possibilities of the work before us are almost beyond calculation. In acting as the representative and agent of the 120,000 physicians of the United States, the association is assuming great responsibilities, which will increase from year to year. It will require administrative and executive ability of the highest order to meet these demands; but there is both prophecy and proof in the work already accomplished that men will appear as needed to discharge the supreme duties of a great profession in behalf of science and humanity.

LEWIS S. MCMURTRY.
LOUISVILLE, KY.

THE RELATION OF PHYLOGENESIS TO HISTORICAL GEOLOGY.

FEW persons would be so bold as to offer serious objection to the great thesis of evolution, to the theory of common descent or to that of the competitive struggle of individuals and species for existence and its selective results, so ably enunciated by Darwin half a century ago. It is, nevertheless, true that of late years there has been an increasing distrust of the theory of the origin of species by natural selection which he therewith proposed, and which was long universally accepted with even less reserve than the author himself expressed. This distrust is especially felt in endeavoring to apply the latter theory to certain lines of paleontological investigation. A number of selected facts are stated at some length on following pages which show abundant reason for regarding that theory unfavorably in such cases. It is there shown that genera, families, orders and classes of animals and plants have, during geological time, usually originated with such comparative rapidity as to make it necessary to infer that species have originated suddenly; that the ratio of progressive development in the different faunal and floral divisions

has not only not been uniform during geological time, but that it has been exceedingly diverse; that those genera, families, orders and classes which have become extinct have, in many cases, declined and perished amid general conditions of physical environment which were evidently quite as favorable to their existence as were those amid which they originated; that certain generic and family forms have survived unchanged through vicissitudes and restrictions of habitation so adverse as to have been again and again apparently more than sufficient for their utter destruction; and that unknown determinate natural causes have acted, sometimes in the destruction, sometimes in the conservation, and sometimes in the extreme differentiation, of typical forms of life, often in seeming independence of environing physical conditions. In making application of those facts it will be shown that some theory of the rapid or sudden origination of species is necessary to harmonize them with the past conditions which they reveal. That the theory of the origin of species by natural selection will not harmonize with those facts will be made sufficiently plain by comparing each of them with the following statement of the chief features of that theory.

That is, that species originate from one another genetically by a process of transformation which requires indefinite time for its accomplishment, and which is, therefore, too slow for actual observation. Such transformation is the result of cumulative repetition, from generation to generation, of small variations such as always prevail in organic forms, until varieties, races, and then species, are produced and the higher groups which they compose are established. Variation is induced and its specific results conserved by physical conditions of environment as a dominant influence and by the struggle for existence under which the comparatively few fittest individuals survive and the infinite number of weaklings, which are born of individuals of all species, perish. Species, therefore, have no definite entity, even when fully developed, but are constantly changing toward the production of other species.

Three of the assumptions which are made by the advocates of this theory are plainly inconsistent with the facts which are presently to be stated, and they only will be discussed on the present occasion. One of them requires the paramount influence of physical conditions of environment for the origination of species and in the conservation of the higher groups which they constitute. One demands immeasurable time for the production of a single species, and consequently the lapse of illimitable time since the beginning of life upon the earth. The other implies that species have no existence as such, but that all of them are in a state of constant change. These assumptions will be separately considered further on.

The accompanying diagram is presented for the purpose of illustrating some of the principal facts that are mentioned in the statements which are to follow.

The horizontal spaces of the diagram represent the respective ages of geological history as they have been determined by the presence and characters of the fossil remains found in their strata. The perpendicular lines represent the principal great groups of animals and plants whose remains are found there. Thus the five lines under *A* represent the five subkingdoms of marine invertebrates, the Protozoa, Cœlenterata, Annuloida, Annulosa and Mollusca. The left-hand line under *B* represents the non-marine, and the right-hand line the land, invertebrates. *C*, fishes; left-hand line, selachians; right,

teleosts. *D*, batrachians and reptiles; left-hand line batrachians; right, dinosaurs; middle, all other reptiles. *E*, birds, single line. *F*, mammals; left-hand line, non-placental; right, placental. *G*, land plants; right-hand line dicotyledons and palms; left, all other kinds. The dotted portion of a part of those lines indicates some doubt as to the epoch in which the kind represented by such a line was introduced.

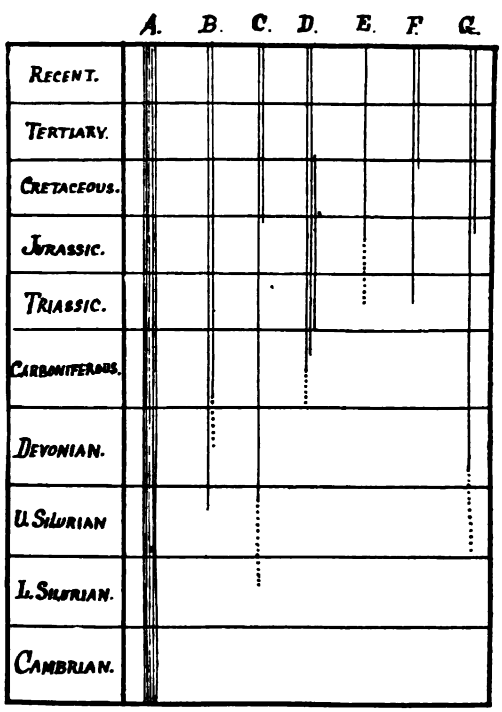


DIAGRAM SHOWING TIME-RANGE OF CHIEF-KINDS OF ANIMALS AND PLANTS.

A, marine invertebrates; *B*, non-marine and land invertebrates; *C*, fishes; *D*, batrachians and reptiles; *E*, birds; *F*, mammals; *G*, land plants.

This diagram thus represents the earliest known epoch of existence of each of the principal kinds of animals and plants, and their continued existence through subsequent geological time. It is a significant fact that, so far as can be judged by their fossil remains, every kind represented on the diagram began its existence with a comparatively high grade of its own types of organization. The instances which will be presented in support of the propositions that were stated in the opening paragraph of this article will necessarily be disconnected in their statement because, in an article like this, there is only opportunity to consider some of the more striking facts selected from a multitude.

The strata of lower Cambrian age contain remains of the earliest forms of life that are known to have existed upon the earth.[1] Large series of rocks, more or less distinctly stratified like those of Cambrian age are, in some regions, found underlying the latter; but no classifiable fossil remains have been found in them, and little evidence has been discovered that life existed before the Cambrian age. The fossil remains which are found in the Cambrian strata pertain to all five of the invertebrate subkingdoms, the vertebrata only being absent; and remains belonging to each of those five subkingdoms are found in all, even the lowermost, of the Cambrian formations. Representatives of those five subkingdoms have continued to exist through all the subsequent ages to the present time in ever-varying forms within the limited scope of their faunal rank, but those representatives were evidently connected by continuous genetic lines, as is represented under *A* on the diagram. So little change is found to have occurred in the general organic rank of those subkingdoms that one may justly assume nearly as high grade for the earliest as for the latest members. Those earliest known animal types either originated with comparative suddenness and then continued through subsequent

[1] For the present occasion I treat the reported fossiliferous Algonkian rocks of Utah and Montana as not older than the lower Cambrian; but even if they are really older, that fact will not affect the validity of my argument, except to enforce it.

time with their chief characteristics unchanged, or they originated in some far distant age of pre-Cambrian time and reached their now known earliest stage of evolution quite as slowly as they have changed since they reached that stage. Aside from the absence of evidence in favor of the latter supposition, it is an improbable one in view of that extremely slow increase of faunal rank in those subkingdoms which has just been mentioned. To indicate that slow increase of faunal rank we may postulate a pair of chronological lines extending from the Cambrian age to the present time as the two sides of an evolutional angle of parallax. The divergence of such a pair of lines would be so exceedingly small that the apex, which would represent the beginning of life, will be carried back into the abyss of time to a point inconceivably remote. It, therefore, seems necessary to conclude that the earliest Cambrian faunas had a comparatively sudden origin, notwithstanding the fact that their development diverged so slowly through subsequent time.

A case partly similar to the one just stated, but which is of narrower faunal scope and shorter chronological range, is presented by the Unionidæ, the oldest certainly known fossil remains of which family are found in Triassic strata.[2] Similar remains are also found in successive formations to the present time, living representatives of the family being abundant in the lakes and rivers of the world. The genus *Unio,* the typical member of that generically small family, is thus known to have existed continuously and unchanged during all that stretch of time in which all the mammals, all the birds, all the teleost fishes, and all the exogenous plants of the earth were introduced, and in which the dinosaurs culminated and became extinct. These earliest representatives of the Unionidæ are fully characteristic of the family, but no certain trace of any previously existing member of it has been found in any older strata. It seems necessary to assume that this family, by its typical genus, was suddenly introduced at that early period, and that it has remained without material change through all the subsequent ages.

One may suggest that the marine invertebrates, which are represented by the five lines under *A* on the diagram, have preserved their faunal integrity through all the geological ages because they had a continuous congenial marine habitat. But the fresh-water invertebrates have survived with quite as little change without such obvious advantages. For example, the Unionidæ were from age to age subject to shifting and adverse conditions resulting from the changing relations of lands and waters, and from the restriction and isolation to which all fresh waters are subjected by intervening land. Their habitable range was also restricted by the marine waters into which their congenial fresh waters flowed. If physical conditions of environment were the dominant factors in phylogenetic differentiation we should expect that these and other faunal groups of fossil fresh-water mollusca would have become widely and profusely differentiated. As a matter of fact, however, those diverse and frequently changing conditions did not result in great differentiation of fresh water faunas in general, a fact which is of importance in this connection. On the contrary, all fresh-water faunas are notably much less diversified than are marine faunas; and fresh-water mollusca especially have retained their primitive types through long geological ages under the

[2] Those Devonian shells which were referred by Vanuxem to *Anodonta,* the several species of the Naiadites of Dawson, and other paleozoic shells, I do not now regard as belonging to the Unionidæ.

vicissitudes just mentioned. Moreover, the most ancient types found among living fishes are denizens of fresh, and not of marine, waters. This fact indicates that the genetic lines of those ichthyic types also were not wholly broken by such shifting physical conditions, and that the genetic lines of their marine congeners were not preserved by having less restricted and more uniform conditions of environment.

The chief object of the immediately preceding paragraph is to show the strong contrast between the conditions which have attended the genetic descent of fresh-water and marine faunas respectively. By way of explanation it is proper to say, however, that the only manner in which unbroken genetic lines of fresh-water faunas could have been preserved through the geological ages to the present time is through unbroken fresh water conditions. Such conditions could have been preserved only by the persistence of rivers in their established channels, so that at least some portions of them, together with their faunas, have escaped destruction by all subsequent elevations and depressions of land surface.[3]

During the Triassic and Jurassic periods the genus *Unio* was the only known representative of its family, and it has always been the leading genus of that family since those periods. This fact shows that, contrary to a prevailing belief, rare genera are not always disappearing or decadent genera. It is also worthy of remark in this connection that although genera were sometimes so long-lived, the geological record shows that the duration of species was comparatively short. The sudden introduction of the Unionidæ by its leading genus, *Unio,* without known congeners, and its survival unchanged through all subsequent ages under peculiarly adverse conditions, are all inconsistent with the theory of the origin of species by natural selection. They are also inconsistent with the assumption that the influence of physical conditions of environment has been a constant dominant factor in phylogenetic differentiation, on the one hand, and of conservation of established living forms on the other.

[3] See my discussion of this subject in Third Annual Report of the U. S. Geological Survey, pp. 479–486.

The earliest known remains of the great subclass of dinosaurian reptiles are found in early Triassic strata, and the latest known representatives of that great subclass barely survived the close of the Cretaceous period, as is shown by the presence of their remains in the upper strata of the Laramie formation, associated with animal and plant remains belonging to Tertiary types. The beginning and end of the comparatively short time range for such a large and diversified subclass of dominant and distinctive animals is shown by the right-hand line under *D* on the diagram. Those strangely peculiar animals were introduced suddenly, soon existed in multitudes, became dispersed over the earth with great rapidity and, from their beginning, they were the dominant animals of all the continents. They varied in size from that of a rabbit to that which would be equal to several large elephants; and the grade of organization for the whole subclass was as high in the earlier as in the later part of its existence. They were differentiated into flesh eaters and plant eaters and into denizens of land and water respectively. We know absolutely nothing of the genetic origin of those remarkable animals, and no traces of similar animals have been found in any strata older than those containing their early Triassic remains. Their world-wide decadence was not delayed by the improving earth-conditions which the mammalia, soon to assume faunal dominion, found abundantly con-

genial; and the last of their kind perished so utterly at, or immediately after, the close of the Cretaceous period that the earth has since contained no living representative of any of them.

I once tried to account for the sudden disappearance of the dinosaurs by supposing the coalescence of continental areas which they occupied with others upon which powerful Eocene mammals had been separately introduced, assuming that the final destruction of the dinosaurs occurred in the fierce conflicts which would naturally follow. But such a suggestion presupposes the contemporaneous existence, in separate regions, of highly organized and characteristic Mesozoic and Tertiary vertebrate faunas, which one is naturally slow to believe. The occurrence of such continental changes has not been proved, and no paleontological battlefields, with mingled remains of the mighty combatants, have ever been discovered. It seems impossible to conceive of the applicability of the theory of the origin of species by natural selection to any of the chief features of the strange faunal history of the dinosaurs, or to their sudden origination and extinction.

We know little or nothing of the ancestry, or of the genetic succession of the unique, abundant and universally distributed flora of the Carboniferous age. It differed materially in character from that of the flora which preceded it, and it was even more different from all succeeding floras. Its forms were so diverse, and their family characteristics so distinctly defined, that the idea of such a gradual transition from one to another as the theory of their origin by natural selection requires seems to be wholly inadmissible.

The palms and exogenous trees, represented by the right-hand line under *G* on the diagram, were introduced with apparently great suddenness in late Jurassic time, and those earliest known plants of their kinds had essentially the same grade of organization that those kinds now possess, although their subsequent evolution has been comparatively slight as regards floral rank.

Birds, having unmistakably reptilian characters, are known by their remains to have existed in the Jurassic and Cretaceous periods; but remains of the earliest known true birds, such as are referable to any of the living orders, are found in strata of the Eocene Tertiary, and they seem to have originated suddenly in that epoch. These, and all living birds, differ greatly from those older kinds, and no intervening kinds have been discovered. It is true that in this case, as in other similar cases, the paleontological record is far from complete, but the epochs in which the older and later forms, respectively, are known to have existed were apparently separated by a time interval which was much too short to have produced such wide differences by the slow process of natural selection.

Remains of the earliest known teleost fishes are found in latest Jurassic and early Cretaceous strata. They were structurally very different from all known earlier fishes and possessed in full the distinguishing characteristics of the teleosts as they exist to-day. To say that no evidence of the gradual and slow evolution of the teleost fishes from older and very different ichthyic forms has ever been discovered is but to repeat what has been said of the sudden appearance of other highly organized forms.

A similar degree of suddenness marks the introduction of the placental mammalia, which occurred about the beginning of Tertiary time, as is shown by the right-hand line under *F* on the diagram. Those highly organized animals assumed faunal

dominion of the earth, which the decadent dinosaurs had departed from. They came in a great diversity of forms, and their organization was little if any inferior in rank to that of the mammals now living of lower grade than the quadrumana. There has been found no evidence of their evolution from earlier forms by any slow process, not even from the previously existing non-placental mammals; and their species all became extinct at, or before, the close of the Eocene epoch. They were then replaced by the Miocene and Pliocene mammalia respectively, each fauna containing many strange and suddenly introduced forms, and each losing largely by extinction. Indeed, the history of the mammalia from the earliest Tertiary to the present time embraces a record of the rapid and varied evolution of the highest grades of animals, culminating in man. If it should ever be possible to trace the evolution of man from the lower animals it will doubtless be found that it has been accomplished, not by the slow process of natural selection, but by a series of sudden mutations.

In the foregoing remarks the terms rapid and sudden, referring to the introduction and extinction of the larger divisions of faunas and floras, are sometimes used in a comparative sense, and sometimes literally. The latter use of those terms, however, is more especially made when referring to species. If the introduction of families, orders and classes, and even of entire faunas and floras, was so effected as to give the appearance of suddenness, or even of rapidity, it necessarily follows that species, which are the recognized component units of those greater groups, were produced with actual suddenness.

The necessity for assuming the sudden origin of species being apparent, the first question that naturally arises is that of the manner of their origination. This must have been accomplished either by special creation, as was formerly believed, or by some natural genetic process of transformation. The time seems to have passed for giving any consideration to the former proposition, and it only remains to consider some natural theory. While many expressions of belief have from time to time been made that species have originated suddenly by some natural process, the only clearly defined theory of this kind is the one proposed by Professor de Vries, of Amsterdam, under the name of the mutation theory.[4] It is essentially as follows:

Species originate from other species through the ordinary function of reproduction, but they each originate suddenly and completely by one mutative act, and not by the slow cumulative variation of individuals. The beginning of the mutative process, which is due to some at present unknown natural determinate cause, is a rearrangement of the groups of component molecules of the protoplasmic contents of the germ cell. It occurs when the ovule containing that cell has, by the natural process of reproduction, been fertilized and is about to give origin to a new individual. If that molecular change occurs, the new individual thereby acquires changed structural characters and becomes an original representative of a new species. If no such molecular change occurs in the germ cell of a fertilized ovule, which is usually the case, the result is only that of ordinary reproduction. The new species thus produced by mutation is in immediate possession of clearly distinguishing and heritably transmissible characters; and it has no more tendency to hybridize with any member of the mother species than have other species. The characteristics and perpetuation of the mother species are in no way affected by

[4] 'Die Mutationstheorie,' von Hugo de Vries, Vols. 1 and 2, Leipzig, 1901, 1902.

the mutative birth of one or more of her progeny.

Species thus produced by mutation are called elementary species. They differ distinctly but not widely from the mother species; wide differences result from the absence of intermediate elementary species. That is, the daughter species become mother species successively; a large part of the mutated, as well as of the ordinary, offspring soon perish in the struggle for existence, even with their own kindred, until wide differences between species of the same stock result. Species are destroyed in the struggle for existence, but that struggle plays no part in their origination.

That species have a real entity and, for the most part, an essentially unchanging existence, are facts of daily observation. They are born, and if they survive the struggle for existence to which they are immediately subjected, they usually have an extended duration; but they finally perish. The duration of a species has two periods, a mutative and a non-mutative period; the former being exceedingly short in comparison with the latter. So very much is the non-mutative period of all species in excess of the mutative, that all the species living in any large region at any given time are likely to be in the non-mutative condition. Furthermore, the process of mutation is so inconspicuous that it may easily escape detection. Attention is particularly called to the fact that mutation, using that term in its here adopted special sense, is as much a natural and normal process as is that of ordinary reproduction, with which function every case of mutation is concurrent. It is also in no way opposed to the great thesis of evolution, and is in full accord with Darwin's theory of common descent.

By referring to the three assumptions of the advocates of the theory of the origin of species by natural selection which are mentioned in the early part of this article, and comparing them with the immediately preceding statement of the mutation theory, it will be seen that this theory is directly opposed to them, but consistent with the facts which have been stated in preceding paragraphs. By further referring to those statements it will appear that in all the cases wherein the inapplicability of the origin of species by natural selection has been shown, the mutation theory is fully applicable. Indeed, the applicability of the latter theory is so apparent that only the following brief comments will be made in conclusion.

The assumption of an illimitably remote period for the beginning of life upon the earth, which the theory of the origin of species by natural selection requires, and which has been vigorously opposed by physicists as inconsistent with cosmical law, is shown by the mutation theory to be unnecessary. That question is, therefore, eliminated from all such discussions because the mutation theory presupposes a rapidity of evolution that would bring the beginning of life quite within the limits required by the physicists.

The comparative rapidity of introduction and dispersion upon the earth of certain genera, families, orders, classes and even of great faunas and floras, makes it necessary to infer the sudden origin of their elementary component units. Those facts and the inference mentioned are as consistent with the mutation theory as they are inconsistent with the theory of the origin of species by natural selection. Furthermore, the persistence of those faunal and floral groups through long periods of geological time with little change after they had become established, makes it necessary to infer the stable entity and

heritability of species. Such an inference accords with the requirement of the mutation theory, but not with the theory which requires perpetual change in all species.

Certain groups of animals and plants have continued their existence without material change under very adverse conditions of physical environment which were seemingly more favorable for their existence than were those under which they originated. The theory of the origin of species by natural selection is at variance with such facts because it recognizes environing conditions as a constantly dominant factor in producing phylogenetic changes, on the one hand, and in preserving the integrity of faunal and floral types, on the other. The mutation theory recognizes the initiative action of an at present unknown determinate natural cause for phylogenetic changes. Environing physical conditions have doubtless been a potent cause in producing variations; and it has doubtless often had a controlling influence upon the destiny of faunas and floras; but such conditions have not been a direct factor in the origination of species.

Whatever criticisms may be made of the de Vriesian theory of mutation, the truth will remain that it accords with numerous important facts with which the theory of the origin of species by natural selection is quite inconsistent. Some theory which provides for the sudden, or rapid, origination of species is made necessary by a large array of geological facts, and the mutation theory more nearly meets that demand than does any other yet proposed.

CHARLES A. WHITE.

SMITHSONIAN INSTITUTION,
February 20, 1905.

SCIENTIFIC BOOKS.

Introduction à la Géométrie Générale. Par GEORGE LECHALAS, Ingénieur en chef des ponts et chaussées. Paris, Gauthier-Villars. 1904. Pp. ix + 58.

The Elements of Plane and Solid Analytical Geometry. By ALBERT L. CANDY, Ph.D., assistant professor of mathematics in the University of Nebraska. Boston, D. C. Heath & Co. 1904. Pp. x + 248.

The Elements of Analytic Geometry. By PERCEY F. SMITH, Ph.D., professor of mathematics in the Sheffield Scientific School, Yale University, and ARTHUR S. GALE, Ph.D., instructor in mathematics in Yale College. New York, Ginn & Co. 1905. Pp. xii + 424.

An Introduction to Projective Geometry and Its Applications. By ARNOLD EMCH, Ph.D., professor of graphics and mathematics in the University of Colorado. New York, John Wiley & Sons. 1905. Pp. vii + 267.

Descriptive Geometry for Students of Engineering. Second edition. By JAMES A. MOYER, S.B., A.M., instructor in descriptive geometry in Harvard University. New York, John Wiley & Sons. 1905. Pp. iv + 198.

The Elements of the Differential and Integral Calculus. By DONALD F. CAMPBELL, Ph.D., professor of mathematics, Armour Institute of Technology. New York, The Macmillan Company. 1904. Pp. x + 364.

Elements of the Differential and Integral Calculus. By WILLIAM A. GRANVILLE, Ph.D., instructor in the Sheffield Scientific School, Yale University. New York, Ginn & Co. 1904. Pp. xiv + 463.

The Boston Colloquium: Lectures in Mathematics. By EDWARD B. VAN VLECK, HENRY S. WHITE and FREDERICK S. WOODS. New York, The Macmillan Company. (For the American Mathematical Society.) 1905. Pp. x + 187.

Except the last these works are all of them addressed to beginners in their respective subjects, and, except the first and last, they are designed for use as text-books in undergraduate study.

The aim of Lechalas's splendid essay is orientation among the fundamental divisions of modern geometry conceived in full generality. Especially intended for such as have not formed a systematic conception of the Euclidean, Lobatchevskian and Riemannian

theories, the motivity and principles of classification are presented in fresh and simple fashion, and the three grand types are made to appear vividly in their true light as together constituting a single exhaustive geometric unit or whole. To this end it is shown, in an introductory chapter, by easy considerations connected with symmetry, reversibility (*retournabilité*) and curvature, that the concept of super-dimensional spaces is logically indispensable. The second chapter accordingly deals with the concept and certain illuminating properties of Euclidean space of four dimensions. The essay closes with a third chapter devoted to analogous features of the geometry of spaces of negative curvature. From the simplest and most familiar considerations to the most remote and recondite, the reader is conducted swiftly and along geodesic paths, but the scenery along the way is rich and stimulating. We take pleasure in recording our judgment, independently formed and concordant with the author's, that the geometry of hyperspace is, at least for certain temperaments, genuinely geometric and not merely analytic as some have claimed. The notion of hyperspace, indeed, rests upon spatial intuition, and the higher spaces that reason has created, the imagination may very well yet learn to picture and illuminate. To those who may aspire to a reasonably competent acquaintance with the elements of *general* geometry, we commend this little book along with Jouffret's 'Traité élémentaire de Géométrie à quatre dimensions,' from which the former draws to some extent, Schubert's essay on fourfold space in his 'Mathematical Essays and Recreations,' and 'Mehrdimensionale Geometrie' by Paul Schoute.

The late Judge Cooley was accustomed to advise his students never to buy a law book not provided with an index. It would be harsh to apply that maxim to Professor Candy's book, for, though it lacks the feature mentioned, it contains others which make it one of the very best among the works of its class. We refer particularly to its emphasis upon the general analytic method as distinguished from limited methods especially available for the conics, and to its fusion and simultaneous treatment of algebra, geometry, equation theory, analytics and calculus, as contrasted with the usual practice of presenting these subjects separately in succession and of so giving the injurious impression that they are as so many separate instruments, or insulated departments, of thought. In the respects indicated we believe the book will prove to be something of a pioneer.

Doctors Smith and Gale 'have endeavored to write a drill book for beginners which presents the elements in a manner conforming with modern ideas.' But these words are obviously not to be taken quite literally. For, on the one hand, a book that is relieved by such live and life-giving topics as invariants, parametric equations, conic systems, homothetic, similitude and symmetry transformations, inversion, systems of orthogonality, poles, polars and polar reciprocation, can hardly be adequately described as a mere drill book; and, on the other hand, its modernity, for it is modern in many respects, would have been, in our judgment, not a little improved by a bold introduction and use of the infinite elements and by allowing imaginaries to play conspicuously their familiar enlightening rôle. It is true that imaginary elements are not properly intuitable; they lack the property of definitely localizable exteriority, and on that account they tend to confuse at first, but only at first, and afterward they give a light which, if it be invisible to sensuous vision, reason at all events demands. We do not believe in the subordination of the intelligence to sight and imagination. It is to the *rational* spirit, which beholds many things inaccessible to the ordinary imagination, that analytic geometry, strictly and properly conceived, addresses itself. And in this subject, the languages of analysis and geometry should be coextensive. We are glad to note that in this work, as in Candy's, the accent falls upon the general analytic method rather than on specific curves, as those of second order. The book abounds in concepts, and these after all are the constituents of intelligence. These being well formed, ratiocination is easy, while without the former the latter is empty and vain.

Professor Emch's book is avowedly utilitari-

an in its aim. Just on that account, it meets a need long distinctly felt in its field. It does not seek to rival in their own way the logicians and 'arithmetizers,' or the purists like von Staudt, or the Italian geometer-ontologists like Veronese, or the 'visualizers' like Enriques. It is more in the spirit of such as Poncelet, Steiner and Chasle, who were less concerned with foundations, which to them were obvious enough, than with superstructure. But it is in no sense a slavish imitator of any type or school. It has a way of its own, and it is refreshing in these peering microscopic days to find your cruder intelligence enlisted without ado, to be ushered at once into the midst of things and in course of the first score of pages to find the atmosphere charged with such cardinal notions as anharmonic ratio, involution, projective transformation, and projective and involutoric pencils and ranges. A second chapter deals with 'Collineation,' a third with 'Theory of Conics,' a fourth with 'Pencils and Ranges of Conics and the Steinerian Transformation in Connection with Cubics,' and a final chapter of forty-five pages with 'Applications to Mechanics.' The method, consistently with the emancipated spirit of modern geometry, is now analytic, now geometric and now a combination of them. For the pure mathematician as such, Professor Emch's book can not be regarded as a substitute for the Cremona and Reye classics, but it will serve for much more than an admirable introduction to them. It differs from them in spirit, content and method. The exposition of the interesting connection between collineations and the surprisingly beautiful doctrine of linkages deserves special mention, as do also the clearness, directness and swiftness of style in which the book is written.

Mr. Moyer has not aimed to write for the geometrician, but for the student of practical engineering. Hence his book does not say that, if such and such propositions be granted, such and such others will follow as logical consequences. It says, if you desire certain specified results, you should proceed thus and so. From some points of view, it seems a pity that such important practice should be so divorced from the theory which constitutes its ground and rational justification. Such detachment, however, is not fatal. The Romans were but meager mathematicians, but they were excellent engineers in their day. Nevertheless we believe that the interests of both theory and practise would be better served if the instruction offered by Mr. Moyer were combined with such a course as that afforded by Professor Emch's book. The time element has of course to be reckoned with. Mr. Moyer's experiment of adopting the notation of mechanical drawing and of introducing many concrete graduated exercises has been eminently successful and these features have been retained in the second edition.

The above listed books of the calculus are evidently, both of them, products of conscientious workmanship. Both of them were composed in the composite light of teaching experience and of modern knowledge of the subject. Guided by the needs of his own classes and therefore excluding all topics not directly bearing upon engineering, Professor Campbell has been enabled, without making his book large or cumbrous, to give a brief introduction to mechanics and differential equations and at the same time to dwell upon fundamental notions and processes. In this last regard, his painstaking and repeated explanation of the way in which summations and integrals are constituted deserves especial mention. Though written primarily for technological students, the book is far from ill-adapted to the uses of so-called more liberal institutions. Professor Granville's work is of larger range, embracing not only the subjects specially adapted to the needs of the student consciously destined for work in applied science, but also those that particularly appeal to the student looking towards specialization in pure mathematics. As well in its scope as in its spirit, the work is distinctly more than the author modestly styles it, 'essentially a drill book.' We especially like its graphic treatment of limits and continuity and its constant appeal to intuition as an indispensable aid to analysis. The geometric and physical illustrations of the significance of the integration constant are happy, to mention a single

feature. Commendable also is the effort throughout to render clear the *meaning* and *limitations* of cardinal theorems. We doubt, however, whether the vexed question whether a variable may attain its limit is, in spirit, quite settled by the ingenious example given on page 20.

The Boston Colloquium consists of three sets of lectures: three by Professor White on 'Linear Systems of Curves on Algebraic Surfaces'; three by Professor Woods on 'Forms of Non-Euclidean Space'; and six by Professor E. B. Van Vleck on 'Selected Topics in the Theory of Divergent Series and Continued Fractions.' The lecturers being all of them former pupils of Professor John Monroe Van Vleck recently retired from the chair of mathematics and astronomy at Wesleyan University, where he had served for a period of fifty years, this volume of lectures is inscribed to him. Each set of the lectures affords a compendious account of the advanced thought in its field, together with indications of existing problems and of the directions that further immediate developments will probably follow. The lectures being of highly technical character and being addressed to specialists, any adequate account of them must be reserved for journals specifically devoted to mathematics.

CASSIUS J. KEYSER.

COLUMBIA UNIVERSITY.

Neudrucke von Schriften und Karten über Meteorologie und Erdmagnetismus herausgegeben von Professor Dr. G. HELLMANN. No. 15 (Schlussheft). *Denkmäler Mittelalterlicher Meteorologie.* Berlin, A. Asher & Co. 1904. 4to. 46 pp. introduction + 270 pp. reprints + 12 pp. addenda and errata to previous numbers.

The publication of this volume, which is the fifteenth and final one of the series, affords an opportunity to congratulate Dr. Hellmann on the completion of so admirable a bibliographical work, which offers to students the advantage of reading in their original form many epoch-making papers relating to meteorology and terrestrial magnetism. Readers of SCIENCE are familiar with the nature of these reprints from the reviews that have appeared in Vol. I., p. 302; Vol. IX., p. 910; Vol. XIII., p. 821; and Vol. XVI., p. 352. Five of the earlier volumes demonstrated that meteorology was actively cultivated in the fourteenth, fifteenth and sixteenth centuries, but in the present issue it is seen that much earlier, and during the entire middle ages, meteorological questions were continually discussed. As illustrations there are given, in part or *in extenso,* 26 writings, dating from the seventh to the fourteenth centuries, inclusive, among them the following examples of famous authors: 'De Natura Rerum,' by Isidorus Hispalensis and Beda Venerabilis; two papers by Albertus Magnus; Roger Bacon's 'Opus Majus,' and 'De Proprietatibus Rerum,' by Bartholomæus Anglicus. Most of the treatises are taken from printed books, but a few are printed from manuscripts for the first time. Certain tracts that were written in little-known languages have been translated into German and so are made accessible to a wider circle of readers, but those in early French, Italian and Dutch appear in the original tongues. It is hardly necessary to say that the facsimile reproductions have been made with the same care that characterized Dr. Hellmann's previous reprints, for the accuracy of which the writer can vouch, having compared several with the originals in his own possession. Their value is much enhanced by the explanatory and bibliographical notes which accompany each.

One or two copies of this last volume have been placed on sale at the Blue Hill Observatory, Hyde Park, Mass., and will be sent on receipt of the publisher's price, viz., 28 Marks, or $7. In conclusion it may be stated that at least four of the earlier volumes are already out of print and command high prices.

A. LAWRENCE ROTCH.

SCIENTIFIC JOURNALS AND ARTICLES.

THE last number of *The American Journal of Mathematics* contains the following articles:

G. W. HILL: 'Deduction of the Power Series Representing a Function from Special Values of the Latter.'

SAUL EPSTEEN AND HEMAN BURR LEONARD: 'On the Definition of Reducible Hypercomplex Number Systems.'

PETER FIELD: 'Quintic Curves for which $P=1$.'

C. L. E. MOORE: 'Classification of the Surfaces of Singularities of the Quadratic Spherical Complex.'

LEONARD EUGENE DICKSON: 'Subgroups of Order a Power of p in the General and Special m-ary Linear Homogeneous Groups in the $GF[p^n]$.

THE introductory article in the May number of the *American Geologist* is a 'Biographical Sketch,' with portrait, of Benjamin West Frazer by Persifor Frazer. This is followed by Professor N. H. Winchell's article entitled 'Deep Wells as a Source of Water Supply for Minneapolis.' This paper, which is accompanied by several plates, is a presentation of the ever-interesting problem of the water supply of cities. Miss Owen discusses the 'Evidence on the Deposition of Loess.' R. R. Rowley contributes a paper on 'Missouri Paleontology,' which is illustrated by one plate of figures and three new species are described. The concluding article is by Professor Warren Upham on 'Fjords and Hanging Valleys.'

The Museums Journal of Great Britain for May notes that the principal subject for discussion at the coming meeting of the Museums' Association will be 'The Relation of Provincial Museums to National Institutions,' a topic to which American members can contribute little, as here there are no relations, save those of good feeling, each museum being independent of others. Under the head of 'A Notable Gift' is recorded the presentation to the British Museum of the reproduction of the skeleton of *Diplodocus carnegiei,* in the museum at Pittsburgh. Under 'Museum Thefts' is noticed the stealing of some Nelson relics from the Liverpool Museum, primarily due to the fact that a case was left unlocked for some months. Apparently English museums do not suffer from the petty thefts of 'relic seekers' who, in our own museums, take articles of little intrinsic but considerable scientific value, thus doing very considerable damage.

The American Museum Journal for April is called the *Brontosaurus* number, its principal topic being 'The Mounted Skeleton of *Brontosaurus*' recently placed on exhibition. Dr. Matthew tells how this skeleton was obtained, transported and mounted, and discusses the habits and habitat of this enormous brute as indicated by the bones. The two new bird groups, the flamingos and the bird life of the San Joaquin valley are also described and illustrated by full-page plates.

The Popular Science Monthly contains the folowing articles:

July.

PROFESSOR W. E. CASTLE: 'Recent Discoveries in Heredity and their Bearing on Animal Breeding.'

PROFESSOR J. LAWRENCE LAUGHLIN: 'Present Monetary Problems.'

H. TAYLOR EDWARDS: 'The Vegetable Fibers of the Philippine Islands.'

DR. GUSTAVE MICHAUD: 'The Climate of the Central American Plateau.'

PROFESSOR A. E. DOLBEAR: 'The Science Problems of the Twentieth Century.'

DR. HENRY RUTGERS MARSHALL: 'Human and other Forms of Consciousness.'

PROFESSOR ARTHUR A. NOYES: 'The Preparation and Properties of Colloidal Mixtures.'

August.

PROFESSOR CHARLES DILLON PERRINE: 'An Eclipse Observer's Experiences in Sumatra.'

PROFESSOR JOHN M. COULTER: 'Public Interest in Research.'

JOHN F. CARGILL: 'The Value of Old Age.'

PROFESSOR GEORGE T. LADD: 'A Suggestive Case of Nerve-anastomosis.'

PROFESSOR HUGO DE VRIES: 'A Visit to Luther Burbank.'

PRESIDENT WALTER NGON FONG: 'Some Phases of the Educational Problem in China.'

PRESIDENT KENYON L. BUTTERFIELD: 'The Social Phase of Agricultural Education.'

DR. W. H. MAXWELL: 'Education for Efficiency.'

'President Roosevelt's Address before the National Educational Association.'

SOCIETIES AND ACADEMIES.

THE OREGON STATE ACADEMY OF SCIENCES.

THE need of some general scientific organization has for a number of years been keenly felt by a number of teachers of science and

investigators in Oregon, who, by reason of their great distance from the scientific centers, are unable to attend the annual scientific convocations and congresses. Many other persons, also, who are not engaged professionally in scientific work have realized the need of organized effort in the interest of the development of the scientific resources of the state. In response to this spirit a call was issued by Mr. Edmund P. Sheldon, upon consultation with others, for a meeting to be held February 4, 1905, in the rooms of the John Burroughs Club, Portland.

At this meeting about thirty persons were present. Mr. Edmund P. Sheldon was elected temporary chairman; Dr. Drake, secretary. Plans of organization were discussed and a committee was appointed to draw up constitution and by-laws for an academy of science. Upon this committee were appointed Professor G. E. Coghill, Pacific University, chairman; Professor A. R. Sweetser, State University; Messrs. M. W. Gorman, Schmidt and Ross Nicholas, of Portland. A committee was appointed, also, to confer with the Lewis and Clark Centennial Exposition Commission with regard to arranging for a scientific congress in connection with the Lewis and Clark Centennial Exposition.

Following the business session a paper upon 'The Bacteriology of Water' was presented by Professor A. R. Sweetser. The paper included an account of the author's investigation of the water supply of certain cities and towns of the Willamette Valley. Special attention was given to the water supply of Portland, which was found to be exceptionally free from liability to bacterial contamination. A device for conveying specimens of water long distances at low temperature for bacteriological examination was exhibited and discussed.

The second meeting for organization was held February 18, Mr. Sheldon presiding; Professor C. E. Bradley, secretary. Constitution and by-laws were adopted, and the organization was formally completed under the name of 'The Oregon State Academy of Sciences.' The following officers were elected:

President—Edmund P. Sheldon, superintendent of forestry, fish and game, Lewis and Clark Exposition Commission.

Vice-Presidents—A. R. Sweetser, professor of biology, University of Oregon; A. B. Cordley, biologist of the Oregon Agricultural College; Catherine McConnell, teacher of chemistry and physiology, Portland High School.

Recording Secretary—J. A. Lyman, professor of chemistry, Portland Academy.

Corresponding Secretary—G. E. Coghill, professor of biology, Pacific University.

Treasurer—M. W. Gorman, botanist, Portland.

Librarian and Director of Museum—L. L. Hawkins, capitalist, Portland.

Trustees—L. L. Hawkins; Dr. James Withycombe, director of the experiment station of the Oregon Agricultural College; Edward A. Beals, U. S. Weather Bureau, Portland.

The constitution provides for monthly meetings, and for special meetings which will no doubt be held annually with a view to calling together the scientists of the northwest.

Two of the regular meetings have already been held. On March 18 a paper was presented by G. E. Coghill on 'The Taste Organs of Vertebrates.' On April 18 Mr. Edmund P. Sheldon read a paper on 'Forestry in the United States.' The paper considered the methods and aims of the forester, the significance of forestry to the nation, and to the state of Oregon especially. Mr. Sheldon's excellent treatment of the subject called forth a spirited discussion of our local and national methods of dealing with the forestry problem.

George E. Coghill,
Corresponding Secretary.

THE TORREY BOTANICAL CLUB.

The meeting of May 31 was held at the American Museum of Natural History, President Rusby in the chair and eleven persons present.

The first paper on the scientific program was by Dr. C. Stuart Gager, and was entitled 'Preliminary Notes on the Effect of Radioactivity on Plants.' Plants grown in the presence of radium are subject to four different influences: (1) The α-rays, composed of a stream of material particles bearing a charge of positive electricity; (2) the β-rays,

made up of a stream of particles 1/2000 the size of those of the α-rays and carrying a charge of negative electricity; (3) the γ-rays, analogous to X-rays, but much more penetrating; (4) the emanation, which in a process of 'decay,' gives off α-rays as described, and eventually the β- and γ-rays mentioned above. The emanation behaves as a very heavy gas and may be condensed on a solid surface at a temperature of —150° C. The influence of radium upon plants, therefore, is of the nature of radiant energy.

The radium was employed in the form of the salt, radium bromide, of three strengths of activity, 1,500,000, 10,000 and 7,000 enclosed in sealed glass tubes, and also in the form of celluloid rods and cylinders covered with Lieber's radium coating of 10,000 and 25,000 activity. The glass shuts off practically all the α-rays, the β-rays penetrate through the glass more easily, while the γ-rays pass through glass very readily. By the use of the coated rods and tubes all three kinds of rays are available as well as the emanation.

The experiments indicate that the rays act as a stimulus, which varies in intensity with the strength and amount of radium used, the thickness of the seed-coats, distance of exposure and the intervention of moist soil between the radium and the plant. If the stimulus ranges between a minimum and an optimum germination and subsequent growth are accelerated. Within these limits the rate of alcoholic fermentation is at first increased, but continued exposure may result in over-stimulation and consequent decrease in rate.

By over-stimulation germination and growth of seeds, gemmæ of Hepaticæ, and pollen grains are retarded and may be completely inhibited. Under the influence of the rays chloroplasts change their position in the cell, as under too intense illumination, and they are eventually destroyed, as is embryonic tissue in stems and roots.

Results similar in kind to the above are obtained by the use of radio-tellurium in a sealed glass tube. The influence here is confined chiefly to the α-rays. Experiments with a rod coated with pollonium, which gives off α-rays exclusively, have thus far given negative results.

Growth is retarded and may be inhibited by growing plants in an atmosphere containing the radium emanation, such as may be drawn from a cylinder lined with Lieber's coating.

Photographs of the experiments and specimens of the various radio-active preparations were exhibited.

The second paper, entitled 'Some Interesting Plants from Colombia,' was by Dr. H. H. Rusby.

In view of the lateness of the hour Dr. Rusby stated that he desired to reserve his paper as planned for some future meeting, when he could take the time to treat it more adequately, and for the present he would show some of the more interesting specimens and briefly comment on the same.

The collections were made by Herbert H. Smith, who spent four years collecting in the United States of Colombia near the town of Santa Marta, which is about fifty miles from the coast in the Sierra Nevada Mountains. Although this territory was collected over quite extensively by Karsten, whose collections are at St. Petersburg and consequently not readily accessible, and by Wm. Purdy, and various orchid collectors, Mr. Smith's efforts disclosed many novelties.

The total collection studied contained about 3,000 numbers, embracing between 2,300 and 2,400 species, of which number about fifteen per cent. are likely to prove new to science.

The specimens exhibited were most interesting, embracing arborescent Violaceæ, handsome twining Senecios, showy Vacciniaceæ, numerous anomalous Compositæ, and many other things undreamt of by collectors in temperate climes.

EDWARD W. BERRY,
Secretary.

DISCUSSION AND CORRESPONDENCE.

EXOGLOSSUM EAST OF THE DELAWARE BASIN.

TO THE EDITOR OF SCIENCE: In the issue of June 30, last, Mr. H. W. Fowler, of Philadelphia, writes on the occurrence of *Exoglos-*

sum maxillingua (Le Sueur), in the Delaware basin. It may be of interest to know that *Exoglossum* also occurs east of the Delaware basin. I caught one in 1899, in Peckman's Brook where the Morris Canal crosses the brook near Little Falls, Passaic Co., N. J. If *Exoglossum* is not indigenous to the Passaic basin it may have reached there from the Delaware River *viâ* Musconetcong River and Lake Hopatcong. This lake is the summit feeder of the Morris Canal. The fish lived for many months in an aquarium. It has the feeding habits of the suckers and remains mostly near the bottom.

EUGENE SMITH.

HOBOKEN, N. J.

SPECIAL ARTICLES.

DISCOVERY OF THE COMANCHE FORMATION IN SOUTHEASTERN COLORADO.[1]

DURING a visit to the Two Butte in Prowers County, Colo., some time ago, I found that a small local uplift east of the butte reveals the Comanche formation filled with characteristic *Gryphœa corrugata*. The locality is on the main, or South Butte Creek, four miles west-northwest of the old town of Albany, or five miles east-northeast of the Two Butte. To the east and west the low bluffs in the valley consist of Dakota sandstone rising gently towards the Two Butte laccolith and the general anticline extending north and south in the southeastern portion of Prowers County. The Comanche beds are exposed just southwest of Mechling's Ranch in a small local anticline and they extend for some distance along the south side of the creek, in low bluffs capped by Tertiary deposits. The lowermost member appearing is a dark shale, more or less sandy, grading upward into a friable, brown sandstone, in part calcareous. The fossils occur in great abundance in the sandstone and sparingly in the dark shale. Owing to overlap of Tertiary sands and gravels, the precise relation to the Dakota sandstone is not clearly revealed, but it is apparent that the Comanche beds lie a very short distance below the main Dakota ledges appearing to the eastward, although probably separated by some dark, nonfossiliferous, sandy shales which lie at the base of the Dakota cliffs in a gorge extending eastward. Probably the Red beds lie at no great distance below, but they do not appear in the immediate vicinity. A few miles west, about Two Butte, the Red beds, with their capping of Exeter sandstone, and included limestone, are extensively exposed. Down stream a short distance, east of Two Butte, the Exeter sandstone is seen to be overlain by shales and limestone of typical Morrison formation, in turn capped by Dakota sandstone. No traces of Comanche beds were found in this vicinity. It was hoped that the relations of the Morrison and the Comanche formations could be ascertained in this general region, but, owing to the apparent failure of the former to reappear in the uplift near Mechling's Ranch, no evidence was obtained on this point.

In December, 1902, Mr. Willis T. Lee gave the Geological Society of America an account of the extension of the Morrison formation down the Cimarron Valley to Exeter, Oklahoma, and the discovery of a low anticline, ten miles farther east, in which the Dakota sandstone is underlain by fossiliferous Comanche beds.

Another item of interest which I observed in the vicinity of Two Butte uplift was the occurrence of oyster shells in considerable numbers in the Dakota sandstone on Butte Creek just below the Downing Ranch, three and a half miles due east of Two Butte and constituting a ten-foot bed a half mile southeast of Pilleau's Ranch on the headwaters of the North Fork of North Butte Creek, five miles north by east of Two Butte.

N. H. DARTON.

U. S. GEOLOGICAL SURVEY.

[1] Published by permission of the director of the U. S. Geological Survey.

SOME OF THE RESULTS OF THREE YEARS' EXPERIMENTS WITH CROWN GALL.[1]

THE diseases ordinarily classed as crown gall are found on the following plants: almond, apple, apricot, ash, blackberry, chestnut, cherry, grape, hop, oak, peach, pear, plum,

[1] Summary of a lecture given at the annual meeting of the American Association of Nurserymen at West Baden Springs, Ind., June 15, 1905.

prune, poplar, quince, raspberry, rose, walnut and willow. Of a number of these, little is known of their nature. Those of the apple, pear and quince are similar in nature, and are not yet proven to be contagious. Those of the almond, apricot, blackberry, cherry, peach, plum, prune and possibly chestnut and walnut, are similar in nature and origin, and are often very contagious. Those of the grape and rose appear to be slightly contagious, but can not be classed with either of the preceding groups with our present knowledge. The crown gall or root galls of the hop contain a slime mold, a *Plasmodiophora* resembling *Plasmodiophora brassicæ*. No study has been made at the laboratory of the disease on the other plants mentioned in the list, but these will be taken up at once in connection with the others.

Careful experiments with apple, quince and pear seedlings raised from sterilized seed in sterilized soil, watered with sterilized water, indicate strongly that both the apple and pear crown gall of the ordinary hard type, the one devoid of numerous side roots or 'hairy roots,' is not contagious. These seedlings of apple, pear and quince inoculated with insertions of live apple and pear galls beneath the bark and wood of the roots, and also with minced galls in the soil, remained free from disease in both the control and inoculated portions of two years' experiments. Carefully selected apple seedlings grown in the nursery were inoculated both in the greenhouse and in field plots. In the experiments for two years the average result from such inoculations was ten per cent. of diseased plants in the inoculated portion and fifteen per cent. in the control portions of the plot. All galls were counted, whether located on the plant at the place of inoculation or not. Extensive inoculation of apple root grafts in the field for two years gives an average of 27 per cent. of plants with galls both in inoculated and control portions of the plots. About 10,000 apple trees were used in the above sets of experiments.

embodying a portion of the results of an investigation at the Mississippi Valley Laboratory of the U. S. Department of Agriculture (Dr. Hermann von Schrenk in charge).

The ordinary apple crown gall is of two types, the one a more or less woody gall with no roots growing from it, the other with few to numerous roots present. The former type has been used in the experiments just described. There is in addition a diseased form called 'hairy root' in which numerous side roots branch from a stunted root. Galls may or may not occur in connection with this form, which is now considered a distinct disease, and which is at present under investigation.

The crown galls of the peach, plum, cherry, raspberry, almond and apricot have been proved by careful inoculation experiments with seedlings of each grown from sterilized seed in sterilized soil, watered with sterilized water, to be one and the same disease on each of these plants. Peach and raspberry are most susceptible to wound inoculation, but also become diseased in infected soil without artificial wounds being made. This disease has not been contagious on the apple, pear and quince.

The results from an experiment with 300 two-year-old apple trees, 175 of which were diseased and 125 healthy, all trees being selected with care to have a uniformity of size and root system, indicate that the disease has no immediate effect on the duration of the life of the tree where other diseases do not enter. At the end of one year, five of the healthy trees and seven of the diseased had died, and no difference in the growth and appearance of the two classes of trees could be noted. This experiment will be continued for a number of years. Field observations bear out the conclusion that the disease does not often kill young trees, as has been asserted.

There is present on the roots of some apple seedlings, and more rarely on grafted apple trees a gall growth of a softer nature, more like that on the stone fruits, and which may prove to be of a slightly contagious nature. A study is being made of this type and the 'hairy root' disease, which also occurs on the cherry and peach. Grafted apple trees often have as high as 50 per cent. of diseased trees, budded trees, on the other hand, usually have

only a small per cent. affected. Most of the galls on grafted trees occur at the lower end of the scion at the point of union of the root and scion. Much of the work of the previous two years is being repeated this year, field plots in eight different localities having been planted with 120,000 apple seedlings and root-grafts.

George Grant Hedgcock.

MT. TSUKUBA METEOROLOGICAL OBSERVATORY, FOUNDED BY H. I. H. PRINCE YAMASHINA.

Since the time of Pascal it appears to have been recognized that the exploration of the upper atmosphere is one of the most important for the advancement of cosmical physics. So long as this ocean remains unexplored, modern meteorology will remain at a standstill, since the thermal, electrical, and dynamic conditions of this ocean are in great measure responsible for the meteorological conditions at the earth's surface. Many balloon ascents and kite experiments have, therefore, been undertaken from time to time, and many mountain observatories have been established in Europe and elsewhere by men who determined to capture the secrets of the upper air.

In Japan, too, the importance of the exploration of the upper atmosphere has been recognized ever since the organization of the meteorological service in 1875. Many meteorological expeditions to high mountains have been undertaken by the officials of the Central Meteorological Observatory at Tokio, and by those of the provincial stations, to investigate the phenomena and processes in the high strata of the atmospheric ocean. For instance, to Mt. Fuji (3,720 meters above sea level) during every summer since 1889; to Mt. Gosaishodaké (1,200 meters) in 1888; to Mt. Ontaké (3,060 meters) in 1891; to Mt. Ishizuchi (1,980 meters) in 1894; and to several other mountains whose heights range from 3,000 meters to 740 meters. But all these expeditions have been undertaken only in the warmest season of the year, on account of the impracticability of long residence on the summits in winter time. For the establishment of a first permanent mountain observatory, we owe thanks to the illustrious Prince Yamashina. His Imperial Highness has selected for his observatory Mt. Tsukuba, a remarkable mountain, which stands lonely on a most extensive plain, isolated from all mountain ranges, and which is, moreover, on that part of the Island Empire where cyclones of a very intense character frequently pass by.

Mt. Tsukuba is situated on the eastern coast of Japan, forty miles north-northeast of Tokio. The shape of the mountain is quite conical and its summit splits into two peaks, the western and the eastern. These peaks are one half mile distant from each other, the west peak being the higher of the two. Though only 2,925 feet, or 870 meters, in height, Mount Tsukuba has a commanding view over Musashino, the most extensive plain in Japan. Still grander is the view southwestward from the top of the mountain. The city of Tokio and innumerable towns are dimly visible on the plain. Many miles beyond, the snow-capped summit of Mt. Fuji, the volcanic peak of the Asama, and the holy mountains of Nikko form a magnificent panorama. Toward the south there is nothing visible but the vast Pacific Ocean fading away into infinite space. The whole mountain is covered with pines and cryptomerias, and its summits are dotted with legendary curiosities and shrines, the largest of which latter are sacred to Izanagi and Izanami, the first god and goddess of the mythological Japan. The legend is that Izanagi and Izanami constructed this mountain as a bulwark against the waves of the Pacific, which they had forced to retire to the other side of Kashima, formerly an island in the sea. This tradition is in accordance with the fact, recently verified by Japanese geologists, that the east coast of Japan has been gradually rising during many centuries past. In the midst of this region of poetry and legend our prince-scientist has established his meteorological observatory on the top of the west peak, which, with its two base stations, has been in active operation since the first of January, 1902. The geographical coordinates of the observatory are:

$\phi = 36° 13'$ N.
$\lambda = 140° 06'$ E.
$H = 870$ meters a. s. l.

The main building is constructed of massive wood on a solid stone foundation and is covered with zinc plates for protection from moisture. The building contains an instrument room, a workshop, an office and rooms for the staff. The observatory is perfectly equipped with meteorological and seismological apparatus of the latest designs. A few yards north of the building there stands a high tower of iron construction (11.6 meters in height), on the top of which an anemometer rests. Prince Yamashina's self-registering anemoscope, Robinson's anemometer, Jordan's sunshine recorder and Richards's anemograph for the registration of the vertical component of the wind, are all placed on the upper platform of this tower. To the west of the main building stands a thermometer shelter, in which thermometers, psychrometers with Assmann's ventilation arrangement, a hair-hygrograph and a thermograph of largest model are kept. Under this shelter, ten earth-thermometers are buried at different depths below the earth's surface, with perfect arrangements for the measurement of the surface and underground temperatures.

On the roof of the main building there may be found a lightning rod, wind vane, self-registering and ordinary rain gauges and an anemometer. The instrument room is elegantly equipped with the best meteorological instruments, the more noteworthy of which are Richards's barograph of largest model, self-registering pluviometers, anemometers, mountain barometers, etc. These are placed on stone piers.

It is worthy of special mention that macro- and micro-seismographs have been installed on a granite pier which rests on a gigantic rock. One of the seismographs is the famous horizontal pendulum seismograph devised by Professor F. Omori, the illustrious seismologist of Japan. All seismographs, including Gray's conical pendulum instrument and Ewing's horizontal pendulum seismograph, record ordinary or strong earthquake motion, but fail to give reliable records of the very small or slow motions accompanying earthquakes and of pulsatory oscillations. Professor Omori has adopted the conical pendulum and has constructed a seismograph which can be made to give records not only of earthquakes, both ordinary and strong, but of very small or slow movements of the earth, accompanying earthquakes or due to distant earthquakes, of pulsatory oscillations and of slow changes of level.

In the International Seismological Congress, which was held at Strassburg in 1901, Professor Omori pointed out the importance of seismological observations on mountains and high elevations. No country had as yet undertaken seismological observations on mountains as high as Mt. Tsukuba, until Prince Yamashina equipped his observatory perfectly with seismological instruments. Since this establishment, many seismic phenomena have been observed, the most extraordinary of which were the horizontal movements of the earth's crust in January, 1902. The horizontal motion of microseismic nature which was east-westwise began at 11:09 P.M. on the fourth of January and lasted until the sixth. Again a movement of the same nature began on the twelfth of that month and lasted for a few days. The seismogram given by Omori's instrument shows that these movements began almost at the same hour on each day and ceased in the same way, and that the curves of oscillations are of the same nature. Horizontal movements of such intense character had never been observed before; the most remarkable fact is that nothing was recorded on the lower level.

In connection with this observatory, two base stations were established by Prince Yamashina. The first one is situated at the foot of the mountain, at the height of 36 meters above sea level. The second was built on the east side of the mountain at the height of 240 meters. All the important meteorological elements are here observed three times daily, besides being self-registered.

The personnel of the observatory consists of several observers and computers. As the positions of the director and meteorologists are

not yet filled, the observatory is under the temporary charge of Dr. T. Okada, an assistant meteorologist in the Central Meteorological Observatory of Tokio, and who is one of the ablest and most active among the young scientists of Japan.

The establishment of the Mt. Tsukuba Meteorological Observatory by Prince Yamashina is certainly the initiative of a permanent meteorological survey of the upper atmosphere in Japan, and there can be no doubt but that this generosity of His Imperial Highness will prove eventually to be a great contribution to cosmical physics. As above mentioned, the topography of the mountain is peculiarly favorable to the study of meteorology and its allied sciences. Moreover, the mountain lies on the route taken by many cyclones, so that the observations at this observatory will contribute as much to the study of atmospheric motions, as they will to the physics of the atmosphere in general.

-S. TETSU TAMURA.

WASHINGTON, D. C.

CURRENT NOTES ON METEOROLOGY.

MONTHLY WEATHER REVIEW.

THERE is much of general scientific interest in recent numbers of the 1905 volume of the *Monthly Weather Review* of the United States Weather Bureau. This publication is becoming more and more indispensable to students of meteorology, and is now well recognized as one of the important meteorological journals of the world. One feature of the *Review* is the monthly list of 'Recent Papers Bearing on Meteorology.' This bibliography of current literature would be far more useful if some system of listing titles were adopted other than that now used. At present the articles are listed under the names of the different journals and other publications. These names are not given alphabetically, and while the number of the volume is given, the year is not included. Where so much space is allotted to these bibliographical lists, it is much to be regretted that some more systematic, and hence more useful, scheme of listing is not adopted. With the first number of the 1905 volume a new list of recent publications is started, under the heading, 'Recent Additions to the Weather Bureau Library.' These, it is to be noted, are arranged alphabetically, but the year is not in all cases given.

The following papers have appeared in recent numbers of the *Review:*

No. 1, 1905, 'Escape of Gases from the Atmosphere,' by Dr. G. Johnstone Stoney, F.R.S., reprinted from the London, Edinburgh and Dublin *Philosophical Magazine and Journal of Science,* Vol. 7, June, 1904, 6th series, p. 620. A subject of theoretical interest in meteorology, but of great uncertainty.

'Meteorological Charts of the Indian Ocean,' by C. F. Talman. For some years the Meteorological Service of India issued daily synoptic weather maps of the Indian monsoon area, for the region between 36° N. Lat. and 12° S. Lat. It has now been decided to extend the field of observation over the greater part of the South Indian Ocean, and also to include broad areas of the surrounding continents and islands. This new enterprise is an important step towards 'world meteorology,' with successful long-range forecasting as the ultimate end in view.

'Apparatus for Instruction in Physics and Meteorology,' by Professor C. Abbe. A few well-considered suggestions as to the inadvisability of using expensive and complicated instruments in schools. Those who have seen teachers and scholars trying to understand fully the workings of some of the more complex instruments will cordially agree with Professor Abbe.

No. 2, 1905, 'A Relation between Autumnal Rainfall and the Yield of Wheat of the Following Year,' by W. N. Shaw, secretary of the Meteorological Council. Read before the Royal Society, February 2, 1905. The author finds that the dryness of the autumn is the dominant element in the determination of the yield of wheat of the following year in Great Britain. This is one of the few investigations which lead to a fairly definite and direct relation between crop yield and the variation of some meteorological element.

'High Water in the Great Lakes,' by Professor A. J. Henry. The outlook for the present season of navigation is not favorable to a

continuation of the high water of 1904, although this will probably rank as a season of relatively high water, especially on the upper lakes.

'The Diurnal Periods of the Temperature,' by Professor F. H. Bigelow. One of Professor Bigelow's studies on the diurnal periods in the lower strata of the atmosphere, in which he undertakes a critical discussion of the results obtained from balloon and kite ascensions during the past ten years.

'Mathematical Theory of Ice Formation,' by S. T. Tamura. A highly mathematical paper, summarizing what has been done along this line by mathematical physicists and also suggesting new lines of investigation.

'The Fourth International Conference on Aerial Research,' being an account of the meeting in St. Petersburg in September, 1904.

'The *Meteorologia Generale* of Luigi de Marchi.' A review of de Marchi's recent book, which is really a short treatise on physical meteorology.

NOTES.

IT is interesting to note the receipt of the First Report of the Transvaal Meteorological Department, containing the observations for July, 1903, to June, 1904, inclusive.

HARROW, as reported in the London *Standard* of June 8, 'has been alone among the public schools in the non-registration and in the non-publication of an annual series of weather observations.' Recently a full equipment of meteorological apparatus, as well as a meteorological library, have been presented to the school. This should serve as an incentive to persons in the United States, where, in spite of much that is encouraging in the situation as regard meteorological instruction, there is still a great deal that needs attention.

DR. W. J. S. LOCKYER, who has been paying special attention to the relation between solar changes and weather, has recently said (*Nature,* June 8, 1905), in a summary of recent work along these lines: 'There is * * * no reason why we should take a pessimistic view of the attempts made to solve this fascinating riddle of the relationship between changes of solar activity and the vagaries of the weather.'

In the *Meteorologische Zeitschrift,* No. 4, 1905, O. V. Johansson has a paper entitled 'Ueber den Zusammenhang der meteorologischen Erscheinungen mit Sonnenflecken-perioden.'

Ciel et Terre, Vol. 26, 1905, No. 5, publishes a useful tabular summary of the temperatures (mean monthly) observed during recent Antarctic expeditions. This is the first summary of the kind which we have seen. It is accompanied by some notes on meteorological phenomena observed during these different expeditions.

The preparation of an index of weather maps illustrating typical conditions, as an aid in forecasting, is discussed by Captain W. Kesslitz in the *Meteorologische Zeitschrift,* 1905, No. 4.

THE actinometrical observations made by A. Hansky, on Mont Blanc, during 1900, are p. 422. Crova apparatus was employed. The value of 3.29 for the solar constant is given as probably the most accurate, on the basis of these observations.

R. DEC. WARD.

SCIENTIFIC NOTES AND NEWS.

DR. NICHOLAS MURRAY BUTLER, president of Columbia University, has received the doctorate of letters from Oxford University and the doctorate of laws from the University of Manchester. While in London Dr. Butler has been entertained by the chairman of the London County Council, the principal of London University, and at a banquet presided over by the minister of education.

THE University of Edinburgh has conferred its honorary doctorate of laws on Professor W. S. Halsted, surgeon in chief of the Johns Hopkins University of Baltimore; Professor I. H. Cameron, of Toronto; Professor Francis J. Shepherd, of Montreal, and Professor W. W. Keen, the Philadelphia surgeon, all of whom are attending the celebration of the quarter-centenary of the Royal College of Surgeons.

LORD KELVIN and Sir William Christie have been elected honorary members of the Optical Society.

The Society of Chemical Industry held its annual dinner in London on July 12, Dr. William H. Nichols, of New York City, presiding. Speeches were made by Lord Alverstone, Professor C. F. Chandler, of Columbia University, Sir William Huggins and others. Among the Americans present were Dr. H. W. Wiley, of the U. S. Department of Agriculture, and Professor Charles Baskerville, of the College of the City of New York.

Mr. John Hyde, chief of the Bureau of Statistics of the Department of Agriculture, has resigned. In his letter accepting the resignation, Secretary Wilson said: "I am familiar with your devotion to your work and with the untiring efforts you have made to render the bureau of the highest service to growers, manufacturers and consumers of farm products in our country, and I regret that failing health should compel you to bring your work to an end."

The Baly gold medal of the London College of Physicians, which is awarded every second year for the most distinguished work in physiology, has been conferred on Professor Pavlov, of St. Petersburg.

The Mary Kingsley medal of the Liverpool School of Tropical Medicine has been awarded to Dr. Laveran, of the Pasteur Institute, Sir Patrick Manson, F.R.S., and Sir D. Bruce, F.R.S.

London University has awarded the Rogers prize of £100 to Mr. B. J. Collingwood, M.B., B.C., for his essay on 'Anesthetics, their Physiological and Clinical Action.' The essay submitted by Dr. A. G. Levy, M.D., was highly commended, and the senate awarded him an honorarium of £50.

Dr. Fred Neufeld, assistant in the Berlin Institute for Contagious Diseases, has been given the title of professor.

Dr. Barton W. Evermann, chief of the Division of Scientific Inquiry and ichthyologist of the U. S. Bureau of Fisheries, has been appointed curator of the Division of Fisheries, U. S. National Museum. He still retains his connection with the Bureau of Fisheries.

The commencement address of the Case School of Applied Science, at Cleveland, was delivered by Dr. George T. Moore, of the Department of Agriculture, upon 'The Creation and Development of Plant Industries by the Government.'

It is proposed to collect a fund in memory of the late Professor G. B. Howes, F.R.S., professor of zoology in the Royal College of Science, London, the fund to be used to purchase an annuity for his widow and daughter. Americans who wish to join in this memorial may send subscriptions to Mr. Frank Crist, 17 Throgmorton Avenue, London, E. C.

A correspondent writes to *The Nation:* "I have been watching for some notice in the *Nation* of the death of Dr. Washington Matthews. Among American ethnologists he ranked not lower than second. Without the horizon of genius to put him on a par with Bandelier, he had a distinction all his own. In all American history, no other one man has known so intimately much about any aboriginal tribe as Matthews did. His studies of the Navajo are the most exhaustive thing of their sort in all our anthropology. He was an extremely modest man, without the gift of popularity, either in his writings or in his intercourse. Of an extremely sweet and unselfish disposition, and much beloved by those who knew him, there was not a bit in him of self-seeking or pushing to the front. He accepted, with a whimsical patience, but with his eyes open, his latter-day function as the original source from which a hundred 'popularizers' built up notoriety for themselves, without credit to him. He was a real martyr—using that abused word without abuse—both to his duty as an army surgeon and his duty as a scientist; and the great mass of accurate and intimate research that he has left to us will always remain among the chiefs of the corner in our scientific edifice."

Sir William Muir, principal of the University of Edinburgh from 1885 to 1903, died on July 11, at the age of eighty-six years.

Dr. Theodor Cleve, professor of chemistry at Upsala, died on June 18.

DR. JOHANN HERMENEK, professor of hydromechanics at the Vienna School of Technology, died on June 15, at the age of forty-one years.

THE U. S. cruiser *Minneapolis*, conveying Rear-Admiral Chester, superintendent of the Naval Observatory, and the other members of the American expedition which will observe the eclipse of the sun at Bona, Algeria, and Valencia, Spain, on August 29, which sailed from New York on July 3, arrived at Gibraltar on July 15. The auxiliary cruiser *Dixie* and the supply steamer *Cæsar*, having on board the instruments and materials for the observation stations, have also reached Gibraltar.

THE French Association for the Advancement of Science will meet during next week at Cherbourg.

THE Royal Institute of Public Health announces that a congress on that subject will be held in London from July 19 to 23, and that papers will be read on discussion held under the various sections of (A) preventive medicine, (B) municipal administration of the Education Acts, (C) child study and school hygiene, (D) engineering and building construction, (E) bacteriology and chemistry, (F) veterinary hygiene, (G) tropical hygiene, and (H) naval and military hygiene.

THE American Medical Association, at its recent Portland meeting, adopted a resolution drawn up by Dr. Liston H. Montgomery, of Chicago, advocating the creation of a new cabinet position to be known as the Department of Public Health, the secretary of which is to rank with other cabinet officers.

THE French minister of public instruction has proposed a grant of 35,000 francs to enlarge the meteorological observatory on Puy de Dôme.

Nature states that it learns from the Royal Society that as an adjunct to the International Laboratory of Physiology on Monte Rosa, a lower laboratory, with a hostel, has been established at Col d'Olen. This lower laboratory is mainly intended for biological research, but it is understood that provision has also been made for the study of terrestrial physics and meteorology. The Royal Society has the permanent nomination to two posts, each of which includes a living room in the hostel, a bench in the laboratory and the use of apparatus; but the expenses of living and of special researches must be borne by the investigators. The laboratory is especially connected with the University of Turin, but is under the immediate direction of a committee.

IN connection with the International Exposition to be held this year at Liège, Belgium, under the patronage of the Belgian government, there will be a second session of the International Congress of Agricultural Education on July 28 and 29.

A REUTER telegram from Paris says: The International Congress on Colonial Agriculture was opened on June 22, Great Britain, Holland, Germany, Italy, Portugal, the United States, Mexico and Brazil being represented. Various papers were read, including one by Mr. Webster, one of the British delegates, on the cultivation of tea in Ceylon. The members of the congress decided to form an international committee for the study of all questions relating to agricultural science and colonial industries. An organizing committee, with headquarters in Paris, under the chairmanship of M. de Lanessan, has been formed. In the afternoon the foreign delegates were received by the municipality at the Hotel de Ville, where a luncheon was given in their honor.

The Journal of the American Medical Association says: At a banquet in aid of the funds of the London School of Tropical Medicine, at which $50,000 was subscribed, Sir Patrick Manson gave a lucid account of the work of the school and sketched a plan for systematic and coordinated research in tropical disease centers. This consists in the establishment of colonial research laboratories in places where they are likely to achieve profitable results. Already three such laboratories have been established—in Ceylon, at Kuala Lumpur, in the federated Malay states, and in Hongkong. Sir Patrick Manson suggested

that one such laboratory should be established for every group of crown colonies, the director to be in organic relation with the London school, but with a free hand to take up any special line of investigation in tropical diseases. The directors of these laboratories should be educated in their special work at the London School of Tropical Medicine; East Africa, Uganda and British Central Africa might form one group, the West Coast of Africa another, the West Indies and British Guiana a third, Fiji and the Pacific islands a fourth. Thus there would be seven laboratories affiliated with the London School of Tropical Medicine. Sir Patrick Manson also emphasized the importance of educating the natives in tropical hygiene. He suggested that tuition in the rudiments of the subject should be included in the curriculum of colonial government schools, so that when the child grows up he may be willing to submit to sanitary measures. Without the cooperation of the natives it is hopeless to try to get any scheme, however good, carried out. A necessary preliminary is the preparation of primers for the instruction of school teachers who in turn would teach children.

THE British postmaster-general has issued a notice that reads as follows: The attention of the postmaster-general has been drawn to the fact that pathological specimens are frequently sent by post by members of the medical profession and other persons in packets which have not been registered as required by the post office regulations. The postmaster-general desires to give notice that the transmission of such specimens is sanctioned only on the condition that they are handed in at a post office for transmission by registered letter post, and that they are packed in accordance with the regulations published in the Post Office Guide. These regulations, which are necessary for the protection of the post office servants and of the public, provide that any deleterious liquid or substance sent by post must be enclosed in a receptacle hermetically sealed, which receptacle must itself be placed in a strong wooden, leathern, or metal case, in such a way that it can not shift about, and with a sufficient quantity of some absorbent material (such as sawdust or cottonwool) so packed about the receptacle as absolutely to prevent any possible leakage from the packet in the event of damage to the receptacle. The packet must also be marked 'Fragile with care.' Any person who sends by post a deleterious liquid or substance for medical examination or analysis otherwise than as provided by these regulations is liable to prosecution, even if he be a patient sending something to his medical adviser for his opinion or a medical practitioner sending something to a laboratory or elsewhere.

UNIVERSITY AND EDUCATIONAL NEWS.

THE British government will allocate £20,000 a year to the new College of Technology at South Kensington out of the treasury subsidy for the maintenance of the Royal College of Science and the School of Mines.

The University Review gives the following figures in regard to the Carnegie Trust for 1904: The trustees during the year had for distribution as grants to the universities and for the endowment of research £59,201. In addition, the income of the trust included £50,000 to be utilized in the payment of the class fees of students who applied to the trust and satisfied the necessary conditions. For this purpose £46,000 was distributed. The figures show that out of every hundred students 72 at Aberdeen received fees from the trust, 70 at St. Andrews, 50 at Glasgow and 39 at Edinburgh. To the general funds of the Scottish universities over £38,000 was granted, and £5,000 was distributed for the encouragement of research at the universities.

DR. H. W. STUART, of Lake Forest University, has been promoted to the chair of philosophy, vacant through the resignation of Professor Walter Smith on account of ill health.

DR. W. G. ADAMS, F.R.S., professor of natural philosophy and astronomy at King's College, London, is about to retire after a service of forty-two years.

PROFESSOR STEPHEN M. DIXON, of Dalhousie College, Nova Scotia, has been appointed professor of civil engineering at Birmingham.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, AUGUST 4, 1905.

CONTENTS.

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

RECENT ADVANCES IN PHYSIOLOGICAL CHEMISTRY.[1]

THE enormously rapid development of physiological chemistry in the last ten years may be well illustrated by a consideration of the new journals which have been found necessary to publish the increasing literature, and also by the influence which this department of science is exerting on other sciences, particularly on medicine. For twenty years the *Zeitschrift für physiologische Chemie* and *Maly's Jahresbericht* were sufficient to represent the specialty, which had been considered a somewhat narrow one, but suddenly, and almost simultaneously, three other publications were called into existence to keep pace with the newly aroused interest. These are the *Biochemisches Centralblatt*, the *Beiträge zur chemischen Physiologie und Pathologie* and the volume on Biochemistry of the *Ergebnisse der Physiologie*, all since 1902.

Several causes have worked to bring about this situation and the most important will be touched on in what follows, but at the outset two things are apparent; on the one hand, there is the stimulating influence of pure organic chemistry, and on the other the requirements of physiology and pathology for a more rational chemical foundation. This last factor is an extremely potent one; some of the most interesting problems of physiological chemistry have been suggested by questions growing out of the discussion of the modern doctrines of immunity and the causation of disease.

It follows, therefore, that many of the advances in physiological chemistry are in lines which are comparatively new, but there are some noteworthy exceptions and of one of these I wish to speak first. This is concerned with the question of protein

[1] Read at Buffalo meeting of the American Chemical Society, June 22, 1905.

in nutrition which has been a much debated problem for fifty years. Indeed, interest in this goes back to the days of the epoch-making publications of Liebig on the relation of organic chemistry to physiology and pathology, issued in the early forties. In these he developed his idea of the functions of various foods in the nutrition of man and laid particular stress on the importance of protein as the source of muscular energy. According to this early Liebig view our foods may be divided into plastic or tissue-forming, on the one hand, and heat-producing, on the other. The production of heat appeared as an end in itself and the fats and carbohydrates served for this purpose. The protein substances are built up into tissues and in the oxidation of the latter, it was held, we have the sole source of muscular energy. The name of Liebig was all-potent in science in those days and his nutrition theory held sway for twenty years or more without question. It will not be necessary to recount the steps in the opposition which finally developed, but it may be well to recall the famous experiment of Fick and Wislicenus in which, in an ascent of the Faulhorn, in 1866, they calculated the work done and the protein oxidized, as measured by the urea excretion. The protein combustion was found to be far too little to account for the expenditure of work in the climb, which result confirmed the theoretical objections urged, especially by J. R. Mayer, of Heilbronn. Other important investigations followed in the same direction, and almost without exception they have gone to show that while the protein oxidation *may* furnish a part of the muscular energy of the body, or even all of it under certain extreme circumstances, the fats and carbohydrates are the usual sources of such energy in man, and that heat production is only incidental, not an end, but an unavoidable accompaniment. A few recent experiments which have seemed to support the Liebig contention have been made largely with carnivorous animals and have no real bearing on the problem as far as man is concerned.

As a necessary consequence of the Liebig theory it was held that our protein consumption must be high, and hence the large amounts of nitrogenous substances insisted upon in the older dietaries. But after a time physiologists naturally began to inquire into the real uses of protein, if it is not called for in the work of the muscles; if, as appeared evident, it is used mainly in the repair of waste tissues, why metabolize so much, since in this metabolism an enormous amount of extra work is thrown on the oxidizing and excreting organs of the body. It certainly can not be assumed that the disposal of the katabolic products of proteins can be accomplished without using up a considerable amount of energy, and without a great strain on the liver and kidneys. What, then, is the amount of protein actually needed for the normal body? Numerous answers have been given to this question and in late years several investigations have apparently brought the daily protein down to 25 to 40 grams, or even lower. But it has been urged against all the experiments leading to such results that they were of too short duration to actually prove anything of value. For example, Siven carried out a 32-day test in which the protein metabolized daily was about 38 grams; during a part of this time the body was kept in nitrogen equilibrium by about 25 grams daily. Hirschfeld somewhat earlier had made numerous observations in which the protein consumption through about two weeks was 35 to 45 grams, but fats and carbohydrates brought the diet up to an equivalent of 3,750 to 3,900 calories.

The importance of the subject is worthy of the fullest investigation, and such a

study has finally been carried out by Chittenden through experiments, first on himself, and then on groups of men engaged in various occupations. In the first of these remarkable experiments, which have recently been described in book form under the title 'Physiological Economy in Nutrition' the distinguished Yale scientist determined in his own case how far he could safely reduce the protein of his diet and still retain the body in nitrogen equilibrium. To do this close watch was held on the food and excreta through a year, November, 1902, to October, 1903, and under varying external conditions of work and temperature. As a result of these systematic tests Chittenden found that he could live very comfortably, and in perfect health, on a diet containing 35 to 40 grams of protein daily, with fats and carbohydrates sufficient to yield 1,500 to 1,600 calories. These valuable personal experiments were regarded as preliminary only. Later, systematic observations were made with three groups of men, the work being carried through periods of five to nine months for each group.

The first group comprised colleagues of the author of the experiments, Yale professors and instructors. The average protein metabolism here was about 46 grams. The second group was composed of soldiers from the hospital corps of the United States army who were detailed for the purpose of the study. Of the twenty who began, thirteen followed the tests through the whole period of over six months. Those who deserted, or were dropped, had much to say through the newspapers about starvation diet, but this was a curious misnomer, since, as the records show, the men who remained were kept in perfect nitrogen equilibrium and found themselves in far better physical condition at the end of the experiments than at the beginning. Through all this time they had plenty of work to perform, with constant and rather severe requirements on the muscular system. The average protein consumption daily was not far from 55 grams.

Finally, eight Yale athletes showed themselves willing to work through the training and competing season on the restricted protein diet. The results here were equally remarkable, in fact probably the most remarkable, as the work done by these men was of a character to call for very high protein diet according to all of our old standards. The experiments were carried out through a period of five months, February to June, 1904, and through the last two months a very close record was kept of diet, excretion, weight and various other factors concerning the men. Through this sixty-day period, when the muscular exertion was, perhaps, the most taxing, protein equilibrium was maintained on an average of 8.81 grams of nitrogen metabolized for each man daily, corresponding to about 55 grams of protein. All these men took high rank in athletic work, several of them being prize winners. The reproductions of photographs, published in the book, show them to be men of excellent physique, and even of remarkable muscular development in some cases. While the protein diet of these men was low the fat and carbohydrates were generous but not excessive, the calorific value of the whole being seldom over 3,000 calories.

For all these men under examination in these three sets of tests, professional men, soldiers, athletes, complete statistics for each day are published, from which the reader may derive the fullest possible information. Painstaking accuracy is evident in every page, and from the standpoint of logical requirement in experimental proof the tables meet any reasonable objection.

This Chittenden investigation then must

be regarded as of fundamental importance, as it demonstrates beyond cavil just what is possible in protein restriction under ordinary conditions. The periods of investigation chosen were long enough to answer objections to the results of some of the earlier tests, and the values obtained for the soldiers and athletes of about 55 grams of protein metabolized daily will have to be taken as practical standards. It doubtless remains true that for men at severe work at low temperatures a large number of calories are required in the food. An instructive example of such dietaries is given in the recent publication by C. D. Woods on the diet of Maine lumbermen, where it is shown that the heat value of the food consumed daily by men in the lumber camps may amount to 6,000 or 8,000 calories. It would be interesting to experiment in such cases on the replacement of a good share of the protein by fat and carbohydrates.

A study of the Chittenden series of experiments on men shows very clearly that as far as the human organism, at any rate, is concerned the old Liebig notion of the source of muscular energy is without foundation. As suggested above, experiments with carnivorous animals do not apply to man; it would be as justifiable to discuss the food value of pentoses for man from experiments on the feeding of straw to cattle. It is true that for short periods, or under special conditions, proteins may serve man as the main or only source of muscular energy, but evidently this is not usually or normally the case.

When the far-reaching importance of the whole question is realized, and when it is further remembered that considerable internal work must be done to remove, especially, the products of protein metabolism, I believe it will be granted that I am right in placing this work of Chittenden among the most important recent achievements in physiological chemistry.

The next topic of which I wish to speak very briefly deals with a problem even older than that of the Liebig theory of the source of muscular energy. Some years before the organic chemistry of Liebig was published Mulder had introduced the term protein, and had even announced the essential composition of what he considered the protein nucleus. His positive statements led to extended investigations on the part of others, and the work of many chemists soon disclosed the fact that no one simple nucleus may be assumed to exist in these molecules and that they must be enormously complex. Ever since the early forties the problem has been an extremely interesting one, but it is only recently that it has been seriously attacked from the second side possible in such investigations. Up to a period within five years the work done on the protein question has been largely in the way of analysis or disintegration, but now we have the beginning of attempts at synthesis or reconstruction of large groups. Glycine and leucine had been known since about 1820 as decomposition products of glue and other bodies by action of acid. Nearly thirty years later tyrosine was added as obtained in about the same way, and soon a few other individual substances were listed among the products which could be secured in various decompositions of proteins. In the seventies systematic methods of hydrolysis by alkalies and acids were worked out, especially by Schützenberger and Hlasiwetz and Habermann. Numerous products were recognized, but at first these attracted no great attention, as there remained always the possibility that the amino acids and other compounds found might be results of secondary reactions. We can not infer much regarding the structure of soft coal from the presence of methane in the gas, or of benzene, tolu-

ene and naphthalene in the tar, and an analogous proposition may be true for the proteins. Later, however, this important generalization was reached; it matters little how the decomposition is effected, the products of protein destruction are essentially the same as long as brought about in the presence of water, and all seem to be in the nature of hydrolytic cleavages. The action of boiling acid or alkali, steam under pressure, pepsin and hydrochloric acid, trypsin and weak alkalies, all lead to nearly the same resultant products, and among these certain α-amino acids are always the most abundant. The conclusion follows, therefore, almost of necessity, that these are the true nucleus groups and the question naturally suggests itself, is it possible to put these things together and build up anything like a true protein. An answer to the question has been slow in coming, but a beginning has been made, and especially through the experiments of Curtius and Fischer. The condensation method followed by the former is a general one, through which a large number of amino groups have already been combined. It depends first on the production of hydrazides, then azides, which are very reactive, and take on additional amino groups with loss of hydronitric acid. For example, the ethyl ester of hippuric acid condenses with hydrazine hydrate to form the hydrazide:

$$C_6H_5CO\,.\,NHCH_2CO\,.\,NH\,.\,NH_2;$$

this with nitrous acid gives the azide

$$C_6H_5CO\,.\,NHCH_2CO\,.\,N_3.$$

By treatment with glycine under certain conditions this reaction follows:

$$\begin{aligned}C_6H_5CO\,.\,NHCH_2CO\,.\,N_3 + NH_2CH_2COOH = \\ N_3H + C_6H_5CO\,.\,NHCH_2CO\,.\,NHCH_2COOH.\end{aligned}$$

In other words, we have started with benzoylglycine and have obtained benzoylglycylglycine. This in turn may be used as a new starting point. A silver salt is made, this turned into ester with ethyl bromide, and then a new hydrazide and azide to be combined with glycine, as before. These steps will lead to benzoyl diglycylglycine, and by using alanine, leucine or other amino acid it will be seen that by repeating the processes extremely complex groups may be finally built up. Curtius has carried the reaction to the formation of benzoyl hexaglycylglycine,

$$C_6H_5CO\,.\,(NHCH_2CO)_6NHCH_2COOH.$$

Hippuryl and three alanine groups have also been condensed to form benzoyl glycyldialanylalanine.

Fischer has worked from a different standpoint. The study of various hydrolytic products from proteins, already referred to, and the isolation of certain other groups by Fischer himself, led to the belief that the complex molecules in the proteins must be built up by the union of amino acid groups. Various attempts had been made to condense some of the simple amino acids in anhydride form, but without much success, until the first experiments were made by Fischer in 1901. The starting point of the series of condensations was found in the product obtained from the glycine anhydride described in 1888 by Curtius and Goebel. This may be looked upon as formed by the union of two molecules of glycine with loss of two molecules of water, and when digested with strong hydrochloric acid suffers a peculiar decomposition and yields a body to which Fischer has given the name glycylglycine.

$$\begin{array}{lr} CO\ \ \boxed{OH\ \ H}HNCH_2 \\ | \qquad\qquad\qquad | \\ CH_2NH\boxed{H\ \ HO}OC \end{array}$$

$$\begin{array}{l} CO \cdot CH_2 \cdot NH \\ | \qquad\qquad | \\ NH \cdot CH_2 \cdot CO \end{array} + H_2O = NH_2CH_2CONHCH_2 \cdot COOH$$

Glycylglycine may be considered as the first anhydride of glycine and is the characteristic group in the hippuryl glycine

from which Curtius has made the derivatives referred to above. In the same connection Fischer explained that a similar reaction follows with the anhydrides of alanine and leucine, from which alanylalanine and leucylleucine must result. To carry the process farther and obtain more complex groups proved practically difficult. Another method was finally developed which may be illustrated by some of the simplest cases described by Fischer. On bringing together a halogen acid chloride, for example chloracetyl chloride, with an ester of glycylglycine, chloracetylglycylglycine ester results,

$$ClCH_2CO \,.\, NHCH_2CO \,.\, NHCH_2COOC_2H_5,$$

which on saponification yields the acid. The latter in turn when treated with strong ammonia gives up chlorine for the amino group and diglycylglycine results. With α-brompropionyl bromide employed as the halogen compound, alanylglycylglycine is obtained, and with α-bromisocapronyl chloride leucylglycylglycine is secured in the same manner.

It will be seen that while the processes of Fischer and Curtius follow different lines they lead usually to the same ends. A considerable number of the Curtius investigations have been published in Vol. 70, N. F., 1904, of the *Jour. prakt. Chem.* under the title of 'Condensations of Amido Acids,' while the Fischer work has come out in recent volumes of the *Berichte* under the general title of 'Syntheses of the Polypeptides.' This work seems to be more directly concerned with the building up of bodies of physiological interest; the Curtius work is somewhat more general. Of many of the Fischer compounds it has been shown that ready hydrolysis with active pancreatic juice follows. The biuret reaction is also given in many cases, but apparently not always. Groups containing tyrosine, cystin, leucine, alanine, etc., have been split by the ferments, and these, it will be remembered, are among the most important of the fractions secured by the hydrolysis of the true proteins. The method of producing these polypeptides seems to be without limit and doubtless much more complex aggregations will be secured. Molecular weights of over 500 have already been reached.

Closely related to the question of the synthesis of the polypeptides is that of the composition of the simplest proteins. The work of Kossel and others in this direction has furnished most interesting results. For several of the protamines and histones the content of hexone bases has been found with a fair degree of accuracy, and of many of the more complex proteins the amounts of both mono- and diamino acids present have been found. The numbers secured must be looked upon, however, as minimum values because of the practical difficulties in the way of quantitative separation and identification.

Several improved processes have been developed for the separation of amino acids from digestion or other mixtures. A method first suggested by Curtius for the production of ethyl esters of the amino acids, and which has been referred to above, has been perfected by Fischer. From mixtures the esters are distilled off under greatly reduced pressure. From the distillate some are separated by solvents, while others, after conversion to acids, are separated by fractional crystallization. It has been found that β-naphthalene sulphochloride combines with many of the amino acids to form compounds of very slight solubility and Fischer and Bergell have developed a method of separation based on this fact. Both general methods have been applied also in the detection and estimation of amino acids in urine which is likely to become a matter of considerable clinical in-

terest, as these acids must represent degenerative or otherwise abnormal products having their origin in the liver and other organs.

Unquestionably one of the most important fields of effort in physiological chemistry at the present time is the study of the soluble ferments, and we have here for consideration not only certain newly discovered enzymes, but, perhaps, of more importance, a great advance in our knowledge of those already known. It was not many years ago that we considered the question of the gastric enzymes as practically settled. The presence of both pepsin and rennin no one could have doubted, but the work of Pawlow and his school in the last five years has thrown entirely new light on the subject and it would appear that one and the same ferment, working under different conditions, is responsible for both classes of observed phenomena. Pawlow has compared the digesting and milk curdling power of ferment secretions from the true pepsin and pyloric glands of the stomach, from the pancreas and from Brunner's glands, and has found them perfectly parallel under proper conditions of experiment; any cause which operates to destroy one power, destroys also the other according to Pawlow. But in any given extract or preparation the conditions must be properly chosen to show both effects. A commercial rennet, for example, may exhibit the milk curdling action very strongly, yet appear to be wholly inert toward fibrin. Pawlow holds that in all such cases simple dilution with very weak hydrochloric acid is all that is called for to show the peptic power. A valuable résumé of this work is given in a recent number of the *Zeitschrift für physiologische Chem.* (Vol. 42, p. 415, 1904).

It is proper to say that the physiologists of the Hammarsten school do not admit the claims of Pawlow, although the doctrines of the latter have been put in very strong light.

To Pawlow we owe, also, the discovery of a new group of ferments which he calls kinases, or activators. The most thoroughly studied of these is the enterokinase which converts the inactive pancreatic juice into an active ferment secretion. As to the value of the other kinases much less is known.

About four years ago Cohnheim described, under the name of erepsin, a peculiar ferment in the intestinal walls which has the power of splitting peptones and proteoses, but not albumins. This discovery grew out of an investigation to determine the fate of the peptone bodies of proteolysis, it being long known that no appreciable amount of these substances appears in the circulation after digestion. A theory grew up to the effect that in the intestinal walls, just before absorption, they were converted back into true albumins. According to the views now advanced by Cohnheim and others this can not be the case to any large extent. The peptones break down with liberation of the carbon and hydrogen excess, which serves as a source of energy, while the nitrogen fractions go over into the form of amino acids, to be further broken down by the liver. This coincides with the view that very little protein is actually needed by the body. On the other hand, it is held by several physiologists that the erepsin katabolism does not go so far, but merely to the production of amino compounds which are ready for a synthesis not yet understood.

If time permitted I should like to go into the question of enzymes in other directions, especially with reference to the work in the liver and the action of the so-called autolytic ferments, the behavior and general importance of which are still very ob-

scure. A large and interesting literature has grown up around the discussion. A word must be said, however, about the important discussion started two years ago by Cohnheim when he announced the relation of two distinct ferments to the oxidation of carbohydrates in the body. The bearing of this on the question of diabetes was immediately recognized and numerous investigations were launched to throw more light on the subject. According to Cohnheim the pancreas furnishes one of these enzymes and the muscle substance the other. One may serve as a kinase or activator for the other and the effect of the two is to facilitate oxidation in the muscles. The subject is immensely important, but the latest studies do not seem to fully confirm all the Cohnheim statements.

In connection with the subject of enzymes reference must be made to the considerable number of papers which have appeared in the last few years on the question of the relation of the ferments to the simple inorganic katalytic agents. Beginning with the work of Tammann published in the *Zeitschrift für physikalische Chemie* many attempts have been made to express the velocity of enzyme reactions by equations analogous to those suggested by Wilhelmy for the inversion of sugar. The extended investigations of Tammann led in general to formulas which were more complicated than those corresponding to the simple logarithmic curve. Some of the more recent work, especially that of Henri, has led to more definite results. This whole discussion has been well reviewed by Bredig in volume 1 of the *Ergebnisse der Physiologie.*

One of the most interesting developments in recent physiological chemistry is in the discussion of theories of immunity and the relations of toxins and antitoxins. As first presented by Buchner, Bordet, Ehrlich, Pfeiffer and others, these doctrines appeared from the chemical standpoint wholly visionary and intangible, but in the last few years a great change has followed in the attitude of chemists and now some of the phrases of the immunity theory of Ehrlich have become part of the language of organic chemistry.

It was early recognized that toxins and antitoxins act on each other in a manner suggesting combinations in definite chemical proportions, and attempts were soon made to work out the laws of the union. The earlier Ehrlich experiments seemed to point to simple combinations like those between an acid and a base, the union following to complete saturation. It was recognized later, however, in many cases, that the reaction is not complete and that the saturation curve is far from being a straight line. These observations led to various speculations. Ehrlich assumed that in the ordinary toxin mixtures we have certain modified forms known now as toxoids and toxons, which, while non-toxic, have saturating power resembling that of the toxins. Hence the amount of antitoxin added to a toxin solution to destroy its toxicity would have to be sufficient to combine, not only with the real toxin, but with any toxoid or toxon present also; just as in neutralizing free sulphuric acid by sodium carbonate the amount of the latter necessary would have to be increased if some salt decomposable by sodium carbonate, such as alum, is likewise present. In the one case as in the other the simplicity of the reaction would be obscured by complexity of the mixture.

Arrhenius and Madsen, and others following them, have been led also to study these extremely important phenomena and have given a different interpretation. According to the notions of the physical chemists these reactions are more or less per-

fectly reversible, which certain experiments seemed to prove, and resemble somewhat the union of an alcohol and an acid which combine to reach a condition of equilibrium. They assume for the toxin-antitoxin reaction the perfect applicability of the Guldberg-Waage mass action formulas, and for a number of relations have calculated the value of the constant k. It is interesting to note that a number of the leading physical chemists have taken part in the discussion. About a year ago Michaelis reviewed the subject in a long article in the *Biochemisches Centralblatt* and this has recently appeared in expanded book form under the title, 'Die Bindungsgesetze von Toxin und Antitoxin.' Michaelis does not accept the Arrhenius work as satisfactory or convincing, and points out several conditions necessary for the applicability of the mass action laws which do not obtain in the cases in question; for example, the mixtures are not homogeneous and the degree of reversibility is extremely limited, if it really exists.

On the other hand, the doctrine of the toxoids and toxons appears to explain the apparent discrepancies and in certain mixtures secured in the experiments of Keyes and Sachs, known to be free from these bodies, the toxin and antitoxin combination followed in proportions represented by an almost perfect straight line.

It remains to add that this whole discussion can not fail to have an important influence on the attitude of medical men to the rapidly developing physiological chemistry. The Arrhenius theory seemed to simplify the question somewhat and make it one of analogy with other well-known phenomena. The facts more recently adduced by the Ehrlich workers do not seem to permit this theoretically preferable solution. The toxoid and toxon hypotheses are necessarily chemical, however, and for the present may better serve in the advance of investigation.

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SCIENTIFIC BOOKS.

The Evolution of Man. By ERNST HAECKEL. Translated from the fifth German edition by JOSEPH MCCABE. 2 vols., 8vo. New York, G. P. Putnam's Sons. 1905.

In the two stately and richly illustrated volumes before us we have a translation of the fifth edition of Haeckel's 'Anthropogenie,' and coming as they do from the pen of one who may now be regarded as a Nestor of zoology and the most vigorous exponent of the historical method of investigation, they present not a little interest. They profess to give in their course of some nine hundred pages an account of the embryological and comparative anatomical evidence bearing on the origin of man, a subject of perennial interest not only to the laity, but also to professional zoologists, since it involves the problem of the origin of the vertebrates.

The work opens with a chapter upon the biogenetic law, or, as it is termed, 'the fundamental law of organic evolution,' and then follow five especially interesting chapters devoted to a history of the development of embryology and phylogeny. To these succeed an extended account of the principal embryological stages of the vertebrates and a discussion of their significance, in which the germ cells, segmentation, gastrulation, the germ layers, metamerism, the fetal membranes and the development of the general form of the body, are all considered from the standpoint of their bearings on the ancestral history. This completed, the author passes on to a consideration of the recent representatives of the ancestral stages and concludes with several chapters devoted to the phylogeny of the various organs of the human body.

It would require much space to consider adequately the entire contents of the volumes, and the purpose of this review will, perhaps, be best served by indicating briefly the line of descent which Haeckel advocates. It is essentially the same as that presented in earlier

editions, of which the third has appeared in an English translation, but differs in the greater detail and precision with which the various stages are defined.

It starts with the Monera, non-nucleated masses of protoplasm which 'stand exactly at the limit between the organic and the inorganic worlds' and have originated by spontaneous generation. Of these, two varieties existed, differing in their physiological activities; the one group, the phytomonera, being plasmodomous, building up protoplasm from unorganized material, and the other, the zoomonera, being plasmophagous, finding their nutrition in already organized material. The phytomonera were the more primitive of the two, the zoomonera arising from them by metasitism or metatrophy, the reversal of the mode of nutrition, a process which may have occurred several times independently and among cytodes as well as moners. Hence not only have zoomonera been derived from phytomonera, but nucleated unicellular plasmophags have arisen from similar plasmodomes, and so Haeckel takes as his second stage of the ancestry the Algaria, represented to-day by such unicellular algæ as the Palmellaceæ. From these he derives the third stage, that of the Lobosa, represented by Amœba and having corresponding to it the ovum stage of ontogeny.

The line of descent is then traced through the moræa, blastæa and gastræa, familiar to all readers of Haeckel's writings, and then passes to the Platodaria and Platodinia, two groups of turbellarian worms represented to-day by the so-called Acœla and the Rhabdocœla. The ninth stage is that of the Provermalia, represented by such recent forms as the Rotatoria and Gastrotricha, and presenting an advance upon preceding stages in the possession of a body cavity and an anal aperture; and to these succeed the Frontonia, a group which many will regard as decidedly heterogeneous, since both the Nemerteans and the Enteropneusta are regarded as being its modern representatives. Then follows the Prochordonia stage, characterized by the possession of a definite notochord and branchial slits and by the absence of a well-defined metamerism; its nearest representatives among recent forms are the copelate ascidians and the appendicularia larvæ.

Haeckel thus omits metamerism as a fundamental and primitive condition whose existence in several groups of animals implies a community of descent; for him it is merely a mode of growth and as such has been independently acquired in different phyla. He regards the metamerism of the annelids and arthropods as something quite different both structurally and phylogenetically from the metamerism of the vertebrates, and consequently excludes the annelids from the line of descent.

The next stage ushers in the vertebrate phylum and is that of the Prospondylia, which finds its modern representative in the larval *Amphioxus,* and then succeeds a stage corresponding to the adult *Amphioxus,* then the Archicrania, represented by the Ammocœtes larva, and then a stage corresponding to the adult cyclostome. The line then passes through the Proselachii, Proganoidea and Palædipneusta, thence through the stegocephalous Amphibia to the Proreptilia represented most nearly by the modern Hatteria, and so to the Monotremes, which represent the Promammalian stage. Then follows the Prodidelphian stage and then that of the Prochoriata or Mallotheria, represented by an extinct group of placental mammals which included the stem-forms of the rodents, ungulates, carnivores and primates and, perhaps, finds its nearest recent representatives among the Insectivora. From the older Mallotheria the Prosimiæ are descended and of these Haeckel recognizes two ancestral stages, the Lemuravida and the Lemurogona, both belonging to Eocene times. From these the Simiæ with a true discoidal placenta are descended, but a discrepancy occurs between the general text, which is identical with the earlier edition in passing directly to the catarrhine forms, and the table given on p. 551, in which the line of descent is taken through primitive platyrrhines and thence through the Cynopitheca. However, the

twenty-eighth stage is that of the Anthropoides, most closely approached by Hylobates among recent forms, and then succeeds the Pithecanthropi or Alali, which included forms similar to, but not identical with, the gorilla and chimpanzee and finally, as the thirtieth stage, comes man.

Without attempting either a general or particular criticism of such a scheme, it may be said of the work that while clearly and interestingly written, it will hardly carry conviction to the mind of the reader. The gaps in the plan are too evident and too lightly passed over; conflicting theories, if mentioned, are treated too summarily; similarities between forms are frequently exaggerated; and, in short, the entire tone of the work is too dogmatic to be convincing. Sentences such as the following are by no means rare: 'In their first stage of development * * * the embryos of all the vertebrates, from the fish to man, are only incidentally or not at all different from each other,' 'Comparative evolution leads us clearly and indubitably to the first source of love—the affinity of two different erotic cells, the sperm cell and ovum (*erotic chemotropism*).'

On the other hand, one looks in vain for many facts which would have added strength to the general argument, and especially is this so in the chapters dealing with the phylogeny of the organs. Much that is highly pertinent has been omitted from the chapters on the muscular and nervous systems, and it is disappointing to find merely a mention of the recent important researches of Schwalbe and Klaatsch on the Neanderthal and Pithecanthropus remains.

But, notwithstanding these imperfections, the book is exceedingly interesting and contains a wealth of information on the questions under discussion. One can not help feeling, however, that it would have gained in value and authority if it had been limited to a discussion of the more general question of the descent of man, without attempting to define some thirty ancestral stages. It is especially in connection with the details that the dogmatism offends.

Finally, it may be remarked that it is unfortunate that more care has not been taken with the translation and proof-reading, in the latter especially with regard to proper names. Thus one finds Dreisch for Driesch, Moll for Mall, Ralph for Rolph, Dalton for D'Alton and Wiederscheim. Numerous terms are employed in the translation which are unfamiliar to English-speaking zoologists, and so much so as to indicate a lack of familiarity with the science on the part of the translator. It is possible to recognize the earthworm in the designation 'rainworm,' but to speak of a Turbellarian as a 'coiled-worm' can not be said to have the authorization of usage; 'tinting and dissection' mean staining and sectioning in ordinary parlance; and it is rather amusing to find one of His's reconstructions described as 'invented' by him. The rabbit is throughout transformed into a hare; *Echidna* is labeled a 'sea-urchin,' and a plate showing variations in the form of the pinna of the ear has for its legend 'ear muscles' (cf. Ohrmuscheln). On the whole, however, the translation is readable and set forth in idiomatic English.

J. P. McM.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Comparative Neurology and Psychology for July contains two leading articles: (1) 'The Sense of Hearing in Frogs,' by Robert M. Yerkes. Although in nature frogs seem very insensitive to sounds, yet both field observations and laboratory experiments show that their hearing is good over a wide range of sounds. The sense of hearing apparently serves rather as a warning sense which modifies reactions to other simultaneous or succeeding stimuli, than as a control for definite auditory motor reactions. Sounds which never cause a motor reaction are found to reinforce an accompanying visual or tactile reaction and under other conditions to inhibit reaction. (2) 'The Reactions of Ranatra to Light,' by S. J. Holmes. A detailed laboratory study of the phototactic reactions of the common water scorpion, with a discussion of the general theories suggested by them.

The July number of the *Journal of Nervous and Mental Diseases* opens with the presidential address delivered at the meeting of the American Neurological Association, June 1, 1905, by Dr. William G. Spiller. Dr. Spiller follows a custom more prevalent abroad than at home on such occasions and discusses a subject of general interest, namely, disturbances in the associated movements of the eyes as affording a sign of localizing value in lesions of the brain. He makes an exhaustive summary of the literature and adds reports of a number of cases of his own, with numerous illustrations. The paper is to be continued in the next number. The second article is by Dr. Smith Ely Jeliffe, of New York, on 'Dispensary Work in Nervous Diseases,' being a report of the clinic of Professor M. Allen Starr for the year 1904. This is followed by a paper by Dr. Robert H. Chase, of Philadelphia, on 'Delusions of the Insane.'

The contents of the *Journal of Infectious Diseases* is as follows:

Tileston, Wilder, and Locke, Edwin A.: 'The Blood in Scarlet Fever.'

Wherry, Wm. B., and McDill, John R.: 'Notes on a Base of *Hematochyluria*, Together with Some Observations on the Morphology of the Embryo Nematode—*Filaria Nocturna*.'

Butterfield, Elmore E.: 'Case of Pulmonary Infection with an Acid-fast Actinomycosis.'

Edwards, Ralph T.: '*Bacillus Mycogenes* (*Bacterium Mucogenum*) Nov. Spec., an Organism Belonging to the *Bacillus Mucosus Capsulatus* Group.'

Wherry, Wm. B.: 'A Search into the Nitrate and Nitrite Content of Witte's "Peptone" with Special Reference to its Influence on the Demonstration of the Indol and Cholera Red Reactions.'

Weaver, George H., and Tunnicliff, Ruth: 'The Occurrence of Fusiform Bacilli and Spirilla in Connection with Morbid Processes.'

Manwarring, W. H.: 'A Quantitative Study of Hemolytic Serum.'

Manwarring, W. H.: 'The Absorption of Hemolytic Ambceeptor.'

Robinson, G. C.: 'The Rôle of the Typhoid Bacillus in the Pulmonary Complications of Typhoid Fever.'

Jordan, E. O.: 'Thermostalbe, Hemolytic Precipitate from Nutrient Broth.'

Gwyn, N. B. and Harris, N. MacL.: 'A Comparison between the Results of Blood Cultures Taken During Life and After Death.'

Guthrie, C. C.: 'A Contribution to the Clinical Knowledge of Texas Fever.'

DISCUSSION AND CORRESPONDENCE.

ANCIENT GREEK FISH AND OTHER NAMES.

In Science for July 7 (p. 23) Dr. C. R. Eastman has given some valuable references to authors treating of the ancient Greek names of fishes but has omitted notice of the most important and trustworthy of all. Besides other data, Cuvier and Valenciennes, in their 'Histoire Naturelle des Poissons' (1828–1849), have embodied quite full notices of the ancient literature concerning the species they treat of. Their greatly superior knowledge of the fauna of the Greek peninsula and archipelago enabled them to make better identifications than any of their predecessors. It is from the neglect of that great work, and not of Artedi's, that Hoffman and Jordan have failed to make their contribution as valuable as it might have been. Had they used the work they would not have fallen into the error of confusing the accounts of the *σχάρσο* and *σπάρος* as they have done—and as Apostolides also has done! In most respects Hoffman and Jordan's work is excellent.

I can by no means assent to the estimate as to 'the extremely valuable historical and bibliographical works of Artedi.' Indeed, there are few errors more deplorable than Artedi's misidentifications which have entailed on ichthyological nomenclature such monstrosities as the use of *Esox* (corrupted from a Gallic or Teutonic name of the sturgeon) for the pike, of *Echeneis* (a blenny) for the sea suckers, of *Exocœtus* (a goby or blenny) for the flying fishes, of *Trigla* (a surmullet) for the gurnards, and of *Callionymus* (a stargazer) for the dragonets. The example thus set was followed by Linné and others, so that most of the Greek names now in use for fish genera have a signification neither justified by ancient usage nor by analogy.

A new English translation of Aristotle's zoological works is a great desideratum. The old translations are poor and inferior to

Barthélemy-Saint Hilaire's French translations. In my youth I had hoped and expected to translate the 'History of Animals,' and even commenced it; other matters, however, distracted me, and I endeavored to interest others, but without eventual success. Some years ago Professor D'Arcy W. Thompson, of Dundee, informed me that he had almost completed a translation, but it has not yet been put to press. A good translation would demand a union of such qualifications as Professor Thompson has, and most of his predecessors did not have—an intimate acquaintance with the Greek language as well as of the Greek animals. The union of President Jordan with Professor Hoffman realized the demand so far as the fishes were involved.

The difficulty encountered by the would-be translator of Aristotle was entertainingly illustrated in 1862. The Rev. W. Houghton, in an article in the *Natural History Review* (II., 136–149), "On the Desirability of an English Translation of Aristotle's 'History of Animals,'" gave a translation of the first chapter of the first book of the history, which was soon criticized (II., 329–332) by Dr. John Scouler and, after a couple of admissions, defended (II., 408–415) by the translator. Meanwhile, in the same year, appeared Richard Creswell's translation. A comparison of Houghton's and Creswell's translations with each other and the original will show how different such may be without either deviating excessively from the Greek text. On the whole, there is no urgent reason to regret that Houghton's translation was not completed instead of Creswell's. The absence of a sufficient knowledge of zoology is, however, sometimes glaringly manifest in Creswell's work, especially in the identifications of the Aristotelian names in footnotes and the index.

Scores of mistranslations or faulty translations occur in Creswell's work, and a couple illustrating the kinds may be cited. "Some animals unite in their nature the characteristics of man and quadrupeds, as apes, monkeys and cynocephali"! (p. 32). This does not represent what Aristotle intended; he meant that some animals combine in their persons characteristics of man and quadrupeds, and instanced as such macaques (πιθηκοι), monkeys (κηβοι) and baboons (κυνοκεφαλοι). The word ape nowadays is mostly limited to the tailless anthropoid apes which were entirely unknown to Aristotle and the Greeks.

Apropos of tails and hair, Aristotle promises to speak of the monkey-like animals subsequently, but notices the hippelaphus or nilgau and indicates that it has a beard under the throat. Creswell says (p. 26): 'the hipellaphus has a beard upon its larynx'! The erroneous spelling hipellaphus is repeated on the same page.

A word as to the use of Aristotle. His zoological treatises are not repertories of exact information to which a learner should be referred, though proclaimed to be such by some. In my youthful days I was advised by an eminent naturalist of the time to study and follow Aristotle. It happened that I had studied and in a special article 'On the Status of Aristotle in Systematic Zoology' (*Am. Nat.* for 1873) I gave reasons why I considered it inexpedient to follow him. Let me add another now. As Dr. Eastman well knows, several paleichthyologists have recently been basing new names on fossil otoliths or earbones of fishes. He and others may be amused by Aristotle's ideas respecting the otoliths of some Greek fishes. "Those which have a stone in their head, as the chromis, labrax, sciæna and phagrus, suffer most in the winter; for the refrigeration of the stone causes them to freeze and be driven on shore" (VIII., xx, 5)!

THEO. GILL.

ENGINEERING PROBLEMS IN A COURSE IN PHYSICS.

TO THE EDITOR OF SCIENCE: Last fall my attention was attracted to a letter published in SCIENCE from a professor of physics in a school of engineering. He asked if others agreed with him that more of 'pure science' ought to be required in engineering courses. At least some of us who are not teaching in either technical or engineering schools feel a need that is just the opposite to the one above expressed. It would be of much assist-

ance to those of us who are not engineers, and, because of preferences in other directions, do not wish to become engineers, to have a laboratory manual which, along with courses in measurement, contains directions for work which is on clearly and definitely stated engineering problems. From our standpoint what we need is to get our teaching in part out of the confines of the class-room and even of the laboratory and bring it more into touch with the commercial application of the work. The following outline, arranged to supplement my laboratory course in heat, may serve to indicate what it seems to me is wanted in each branch of physics. If there is a laboratory guide published which includes such plans, I should like to know of it.

SUPPLEMENTARY WORK IN PHYSICS. II. HEAT.

1. Coal.

Plan an experiment to determine the amount of heat generated in the combustion of a pound of coal, and write out a report in full in the usual form, leaving blank spaces for the insertion of the data when obtained. After consultation as to the plan you may determine how many pounds of water a pound of coal will raise one degree Fahr. when no heat is lost.

Average data for comparison: Heat from the combustion of one pound of anthracite coal will raise the temperature of 14,000 pounds of water 1° F. Heat from the combustion of one pound of coke will raise the temperature of 14,000 pounds of water 1° F. Heat from the combustion of one pound of crude oil will raise the temperature of 19,000 pounds of water 1° F. Heat from the combustion of one pound of gas will raise the temperature of 1,000 pounds of water 1° F. Heat from the combustion of one pound of hard wood will raise the temperature of 8,500 pounds of water 1° F. Heat from the combustion of one pound of soft pine will raise the temperature of 9,000 pounds of water 1° F. Heat from the combustion of one pound of peat will raise the temperature of 6,000–10,000 pounds of water 1° F. There are no data on the kind of coal which we have.

2. Boiler. (Study of boiler at the college heating plant.)

The engineer will tell how much the level of water in the boiler has been lowered in one day without return of water to the boiler, and how much coal was actually used.

How much would have been needed to evaporate this water under the pressure of forty pounds per square inch if no heat were lost? What is the efficiency of the boiler? What horse power was actually generated?

About ten square feet of heating surface are needed per horse power. What is the rating of the boiler?

The ratio of water heating area to the area of the grate is generally 20–25 to 1. What is the ratio in these boilers?

What is the pressure of steam in one of the boilers? Determine with a thermometer the temperature of the water in the boiler. How does this temperature compare with the temperature given in the curve of steam pressure?

3. The System on Heating.

Follow the steam pipes to the tunnels, determine the use of each pipe and see what the different valves control. Is any part of the system not under complete control? How is air removed from the pipes? In what different ways may water be obtained and forced into the boilers?

What is the temperature of steam in the mains? What is the temperature of the water in the return pipes? How much heat was radiated from the radiators and pipes? (For quantity of steam, see data obtained on boilers.)

Make the necessary measurements in the room assigned you to determine the number of cubic feet of space, the area of the radiating surface, etc., and ascertain whether there is sufficient radiating surface for the room. The following is one of the tables used in such estimates: For each 200 cu. ft. of space allow 1 sq. ft. of radiating surface. For each 20 sq. ft. of exposed wall allow 1 sq. ft. of radiating surface. For each 2 sq. ft. of glass allow 1 sq. ft. of radiating surface. If the building is poorly constructed twenty per cent. is added to the radiating surface. (To save a large part of the computing, see tables on page 6, Mechanics' Pocket Memorandum.)

If a hot water heating system were used five thirds as much radiating surface would be required. What is the exact ratio between the heat given out in the pipes by a quantity of steam at one and one half pounds pressure and the same quantity of water at 150° F., both cooling down to the temperature of the water in the return pipes? What bearing does the curve of cooling which you have drawn have on the selection of a ratio for estimates?

4. Engine (at electric light plant).

Explain how the valves control the steam ad-

mitted to the cylinder. At what pressure is the steam when admitted to the cylinder? What is the temperature of the steam for this pressure? (See curve of steam pressure.) Does the maximum pressure recorded on the indicator card correspond to that registered by the steam gauge? During what fraction of a stroke is the maximum pressure upon the piston exerted? (See indicator card.)

Ascertain the internal dimensions of the cylinder. What is the temperature and what the pressure of the exhaust steam?

How many units of heat disappear as the quantity of steam which enters the cylinder at one time expands to the temperature and pressure at the close of the stroke? (For final pressure see indicator diagram.) How many units of heat disappear as the quantity of steam which enters the cylinder at one time expands to the temperature and pressure of the exhaust steam? (In what other ways has heat disappeared?) What efficiency do these figures indicate?

Count the number of strokes per minute, and determine the average pressure of steam in the cylinder. (See indicator diagram.) What horsepower is the engine developing?

If the exhaust steam were conducted to another cylinder attached to the same shaft and all the heat which escapes to the exhaust were utilized in this second cylinder, how many times larger should the area of the piston be than that of the first, the length of stroke in the two engines being the same?

Assuming the boiler at this plant to have the same efficiency as that of the boilers at the college heating plant, and omitting further loss by radiation from the steam pipes, what part of the energy developed in the burning of a pound of coal actually appears as work? JOHN L. TILTON.

SIMPSON COLLEGE,
INDIANOLA, IOWA.

ARGUMENTS ALLEGED AGAINST THE DOCTRINE OF ORGANIC EVOLUTION.

TO THE EDITOR OF SCIENCE: It is not often that in a single article emanating from good authority, one is able to find, in concise form, many of the so-called arguments of the anti-evolutionist against the theory of the animal descent of man. One of the most typical and most recent of these expositions upon the relation of belief in this theory, with Biblical teachings and established scientific facts, together with what purports to be a registration of vital points which would make a belief in the evolution theory incredible, has come from Professor L. T. Townsend, of Drew Theological Seminary, in an address entitled, 'The Collapse of Evolution,' delivered recently before the American Bible League, at the Boston convention.

This exposition appears to give in brief form, an excellent idea of the attitude of the average anti-evolutionist in respect to some of the fundamental principles of the descent theory (especially from the theological standpoint). Believing that there may be some of your readers who would appreciate a concise statement of this attitude, and of the arguments which so many of the more conservative anti-evolutionists of theological profession hold towards certain phases of this much troubled question, I have ventured to enclose to you in brief, argumentative form (although the address does not readily lend itself to such arrangement) an account of this article which, so far as I am aware, has appeared only in a periodical of limited circulation, *The Bible Student and Teacher;* and which, to my mind, shows the theological anti-evolutionist's standpoint in a definite and concise manner.

I undertake at this time no criticism of any part of Professor Townsend's argument, but attempt merely to state the argumentative points of the address in the clearest and most logical sequence possible. That many points require criticism will be apparent to the most casual reader; that, however, I leave to others. The following is the gist of the argument:

ASSERTION.

The theory of evolution and the animal descent of man is a poorly constructed affair, supported by not one single well-established fact in science, philosophy or religion, for:

I. The assertion that the original germs of animal life do not require the supernatural is false, for:
   1. Natural forces to-day can not produce the same germs.
   2. Spontaneous generation, in any sense, is not proved possible at the present day, 'and is no longer mentioned in scientific circles.'

3. Many famous biologists have abandoned the theories of the natural origin of life, for:
   A. Huxley was led reluctantly to give up his bioplastic theory.
   B. Sir William Thomson surrendered his speculation that life germs came to this earth from some planet.
   C. Herbert Spencer abandoned his theory of the 'chemical origin of life.'
   D. Tyndall said: 'Proofs that spontaneous generation has occurred at any time in the earth's history, are still wanting.'
   E. Virchow held that there was no evidence that the original germs arose by spontaneous generation.

II. There is no truth in the law of universal development and improvement of animals, for:
1. From the 'primordeal zone' to the present, the multitude of species have shown no improvement since their creation, for:
   A. The marine algæ found to-day are no more perfect than those found in the distant Silurian period.
   B. Among trees, the oak, birch, hazel, Scotch fir, have shown no improvement in thousands of years.
   C. The coral 'insects' which built the first coral reefs in Florida, have shown no improvement in 300 centuries.
   D. The crustacean family, since its appearance at the close of the carboniferous period, has not changed.
   E. The molluscs, fishes, reptiles, birds and mammals have never shown the least improvement or elaboration since their appearance.
   F. Mummies of cats, bulls, ibices, birds, dogs and crocodiles from the tombs of Egypt, have shown no change in 5,000 years; are identical with their living representatives of to-day.
   G. The 'Cro-Magnon' skull belonging to the earliest stone age, is not different from the human skulls of to-day.
   H. A scientist, having examined the statuettes recently discovered in Crete, concludes that the muscles and veins of the forearm of man have not changed in 4,000 years.
2. On the other hand, in scores of instances there is a pronounced deterioration of both parts and functions, for:
   A. One may observe cases of degeneration in:
      a. The acidians.
      b. Many parasitic species.
      c. The fishes (constant degeneration since the Devonian period).
      d. All the lower mammals.
      e. The whole human race.

III. There is no such thing as transmutation of species by natural processes, for:
1. The proofs which evolutionists have brought forward in favor of transmutation are in reality, meaningless, for:
   A. Geological records do not uphold the theory, for:
      a. In such cases as the supposed phylogeny of the horse, the resemblances between the original four-toed animals and the modern horse, 'are no greater than those between a cow and a crow, or between a man and a mouse; and this is no evidence of transmutation.'
      b. The so-called missing link, pithecanthropus erectus, is no evidence, for:
         a'. At the meeting of famous zoologists at Leyden, only seven out of twenty-four agreed that the 'pithecanthropus' was a missing link.
         b'. Professor D. C. Cunningham, of Dublin, concluded that this lot of bones was part baboon and part human.
   B. Biological records do not uphold the theory of transmutation, for:
      a. Manifestations of the principle of the biogenetic law furnish no support for the theory, for:
         a'. This law but shows the 'prophetic element in nature'; *i. e.*, the creator is a prophet and his method is to anticipate by type, pattern or prophecy, what may be expected in his subsequent creations.
      b. The ease with which present-day scientists can place in its proper class and order any fossil or prehistoric animal, is a sign that species have not changed.
      c. No one has ever been able to change the structureless germ of one plant or animal into the structureless germ of another.
      d. Sterility of the offspring of crossed species bars the most available way for the process of transmutation to act.

IV. There is no emergence of man from the brute condition, for:
1. Geology, history, archeology, anatomy, philology, ethics and religion demonstrate the fact that the first beings on earth which

wore the human form were not brutes nor even barbarians, but were as perfect in brain and as capable in intellect as any people now living, for:

A. Geology, archeology and anthropology all concur in the facts that:

a. The human race was not existent before the close of the glacial period; *i. e.*, about 15,000 years ago.

b. Man was highly civilized 7,000 years ago, and has not materially changed since that time.

c. There is left only 8,000 years for the rise of man from the brute condition—a fact which is incredible when we note that man has not changed at all in the last 7,000 years.

B. Philological research demonstrates the fact that the languages of all primitive tribes have undergone a descent rather than an ascent.

C. A study of comparative religion shows that all forms of worship emanated from a true worship of one supreme being.

D. The ethical codes of the ancient Babylonians and Egyptians excelled in loftiness and purity ours of the present day, which have degenerated.

V. The scholars and scientists are not all evolutionists, for:

1. Dr. N. S. Shaler, of Harvard University, says: 'It begins to be evident to naturalists that the Darwinian hypothesis is still unverified. Notwithstanding the evidence derived from animals and plants under domestication, it has not been proved that a single species * * * has been established by the operation of natural selection.'[1]
2. St. George Mivart, of the University College, Kensington, says of the theory: 'I can not call it anything but a puerile hypothesis.'
3. Dr. Etheridge, of the British Museum, remarks: 'Nine tenths of the talk of evolutionists is sheer nonsense; it is not founded by observation, and wholly unsupported by fact.'
4. L. S. Beale, of King's College, London, says: 'There is no evidence that a man has descended from, or is or was in any way specially related to, any other organism, in nature, through evolution or any other process.'
5. M. Stanislas Meunier, of the Paris Museum, argues in favor of special creation by an infinite power.
6. Virchow, speaking of evolution, said: 'It is all nonsense. It can not be proved by science that man descends from the ape or from any other animal.'
7. Fleishmann, of Erlangen, said: 'The Darwinian theory of descent has not a single fact to confirm it. It is a product of the imagination.'
8. Edward von Hartmann in his work, 'The Passing of Darwinism,' shows that the theory is now incredible.
9. Dr. A. H. Sayes, of Oxford, says: 'The application of the evolution theory to the religious and secular history of the world, is founded on a huge mistake.'
10. Many others, as Donnert, Goette, Hoppe, Paulsen, Rutermeyer, Wundt, Zoeckler and Griefswald, once supporters of evolution, have now abandoned it.

CONCLUSION.

In view of the facts:

1. That the advocates of evolution can not prove that life germs arose by natural processes;
2. That evolutionists show an utter inability to prove that there exists a universal law of development and improvement;
3. That they can not prove lower species of plants can be transmuted into higher;
4. That in all excavations not a single connecting link between species has been discovered;
5. That physical and mental science proves it to be impossible for an animal to come into possession of a human soul, human mind or human body;
6. That geologists have silenced the voices of the advocates of the animal descent of man;
7. That all scholarly men and scientists are not evolutionists;
8. That many who once upheld evolution are now abandoning it;

There need not be a moment's hesitation in saying that the hypothesis of evolution, with all the other speculations attached to it, has collapsed beyond the hope of restoration.

Phil. B. Hadley.

Anatomical Laboratory,
Brown University,
March 4, 1905.

[1] This is a misinterpretation of Dr. Shaler's attitude which is decidedly in favor of some evolution hypothesis.—P. B. H.

SPECIAL ARTICLES.

EFFECT OF THE CONCENTRATION OF THE NUTRIENT SOLUTION UPON WHEAT CULTURES.

The work here reported was undertaken to determine the concentration of a nutrient solution which is best adapted to the growth of wheat, and further to find out whether or not an increase in concentration alone may accelerate growth aside from changes in the nutrient value of the solution. The nutrient solution used contained calcium sulphate, magnesium phosphate, potassium carbonate, sodium nitrate and ammonium chloride in chemically equivalent amounts. It was made up to concentrations of 10, 70, 150, 745 and 1,545 parts per million, respectively. To each solution 5 parts per million of ferric chloride were added, thus making the concentrations of total salts 15, 75, 155, 750 and 1,550 parts per million. In the two higher concentrations some phosphates and carbonates of calcium and magnesium were precipitated out, but the error thus produced is too small to affect the general results under consideration.

A series of cultures of wheat seedlings was grown for 28 days in these solutions, the latter being changed every day. At the end of the period the plants in the solution of 15 parts per million were the poorest of the lot, being remarkably stunted, as though suffering for want of water. Those in the solution of 75 parts per million were considerably better, while those in the solution of 155 parts per million were unmistakably the best. Those in the solution of 750 parts per million were similar to those in the one of 75 parts, while those in the solution of 1,550 parts per million were again very poor and showed the same stunting of growth as do plants growing in alkali soils.

This experiment was performed six times with different growing conditions, and each time the results were in the same order. The general development was always in the same relative order as the transpiration.[1]

[1] For evidence in regard to the use of transpiration as a criterion here, see a paper about to appear in the *Botanical Gazette*, Livingston, B. E., 'Relation of Transpiration to Growth in Wheat.'

In Table I. are given the number of plants used in each experiment and the relative transpirations for the different cultures of the six experiments, all calculated to a uniform basis of 15 days each. In calculating the relative transpirations, the total transpiration of the culture in the weakest solution is considered as 100.

TABLE I.

Data for Experiments I. to VI.

Exp. No.	No. of Plants.	Relative Transpirations for Period of 15 days in Nutrient Solutions of the Following Concentrations:				
		15 p. p. m.	75 p. p. m.	155 p. p. m.	750 p. p. m.	1,550 p.p.m.
I.	24	100	209.3	330.2	197.6	253.5
II.	36	100	132.6	154.4	134.3	107.3
III.	36	100	134.9	181.3	158 9	81.4
IV.	24	100	151.6	151.6	138.3	120.0
V.	24	100	186.1	157.0	193.0	125 5
VI.	60	100	155 5	157.9	157.9	104.1
Av. for 204 plants.		100	161.6	188.7	163.3	131.9

It will be seen from the table that curves of these transpirations would have maximum points somewhere between 155 and 750 parts per million of total solids in solution. No attempt was made to determine the maximum point more accurately, but by interpolation it is estimated to lie in the vicinity of 300 parts per million of total solids. This may be taken as approximately the concentration best suited to growth under the conditions of these experiments.

Whether the depression noticed in the lower concentrations of the above series is due to a scarcity of one or more of the nutritive elements or to the low concentration of the solution as a whole is considered in the following experiments. In experiment VII. to each of four portions of the solution above described, containing 15 parts per million of total salts, were added 140 parts per million of one of the salts occurring in the original solution, a different salt being used in each case. To a fifth portion was added 140 parts per million of a mixture of all four of these salts in chemically equivalent amounts. Twenty-four plants were grown in each of the five solutions for thirteen days, and their growth was compared with that of a similar culture in the

original solution. Table II. presents the data for this experiment as well as for the two following ones. Relative transpirations on the basis of 100 for the original nutrient solution of 15 parts per million are given. There was a marked increase in the growth of the plants, with the addition of each one of the salts, but none of them produced as good plants as did the combination of all four salts.

In experiment VIII. the same solution of 15 parts per million was increased in concentration by the addition of 60, 140, 735 and 1,535 parts per million of calcium sulphate. Thirty-six seedlings were grown in each solution for thirteen days, comparison being again made with the original solution. The increase in transpiration was also very marked in this case, as is shown by the data in Table II. Here the transpiration figures tend to show a depressing effect in the solution of highest concentration, as in the former case. This experiment was repeated with similar results.

Table II.

Data for Experiments VII. to IX.

	Medium.	Relative Transpirations for Period of Experiment.
	Nutrient solution, 15 p. p. m.	100.0
	Do. + 140 p. p. m. $CaSO_4$.	205.5
Experiment	Do. + 140 p. p. m. $MgHPO_4$.	143.5
VII., 24	Do. + 140 p. p. m. K_2CO_3.	224.4
plants, 13	Do. + 140 p. p. m. $NaNO_3$.	156.2
days.	Do. + 140 p. p. m. of four above salts, in chem. equiv. amounts.	241.9
Experiment	Nutrient solution, 15 p. p. m.	100.0
VIII., 36	Do. + 60 p. p. m. $CaSO_4$.	117.8
plants, 13	Do. + 140 p. p. m. $CaSO_4$.	157.7
days.	Do. + 735 p. p. m. $CaSO_4$.	188 9
	Do. + 1535 p. p. m $CaSO_4$.	155.5
Experiment	Nutrient solution, 15 p. p. m.	100.0
IX., 60	Do. + 60 p. p. m. NaCl.	111.1
plants, 15	Do. + 140 p. p. m. NaCl.	114.9
days.	Do. + 735 p. p. m. NaCl.	117.2
	Do. + 1535 p. p. m. NaCl.	95.4

Sodium chloride, which furnishes none of the elements usually classified as plant food materials, was also used to increase the concentration of the original solution. Sixty plants were used in this case, being grown for fifteen days. The treatment was the same as that with calcium sulphate just described, and the results showed the same general effect, although the actual differences between the different cultures were not nearly as great. The last fact is probably due to the toxic effect of the chlorine ion, tending to retard growth and thus partially masking the effect of concentration. The data are given in Table II.

From the experiments thus far described it is evident that there is an optimum physical concentration of the nutrient solution at which water cultures of wheat thrive best, aside from variations in the amounts present of the different nutrient materials. In the solutions of lower concentration the retarding factor for plant growth is not necessarily connected with the low osmotic pressure, for the same acceleration of growth which is observed to accompany an increase in concentration can be obtained by entirely different means. The author has already called attention to the fact that both nutrient solutions and soil extracts are greatly improved for the growth of wheat by addition of small quantities of the practically insoluble bodies, carbon black and ferric hydrate[2] and that the beneficial effect of these bodies is due to their power to absorb toxic substances. Such toxic materials are present in many soils, and physiologically similar ones are given off by the roots of wheat grown in water culture.[3] The addition of these insoluble bodies to a weak nutrient solution can not possibly increase its concentration to any appreciable degree; indeed, such addition is apt to decrease its concentration to some extent owing to phenomena of adsorption. Yet such treatments result in the same sort of acceleration of growth as is obtained with increase in concentration.

Dr. B. E. Livingston, of the bureau of soils, has made possible a quantitative comparison in this regard by furnishing the author with

[2] Breazeale, J. F., 'Effect of Certain Solids upon the Growth of Wheat in Water Cultures,' about to appear in the *Botanical Gazette*.

[3] In this regard see Livingston, B. E., Britton, J. C., and Reid, F. R., 'Studies on the Properties of a Sterile Soil, U. S. Dept. Agric., Bureau of Soils, Bul. No. 28.

unpublished data from experiments which he has recently performed. He finds from an average of six different tests in which ferric hydrate was added to the nutrient solution described above, the latter having a concentration of 75 parts per million; that growth is accelerated by this treatment to an extent equivalent to 26.2 per cent., the growth obtained in the untreated solution being considered as unity for the comparison. The same nutrient solution with carbon black gave 35 per cent. increase in growth on the same basis. The last figure is an average of the results of two experiments.

TABLE III.

Data for Experiment XI.

Solution Used on Sand.	Transpiration for 2 Days.	
	In Grs.	Relative.
Nutrient solution, 15 p. p. m.	44	100
Do. 75 p. p. m.	45	102.3
Do. 155 p. p. m.	65	147.7
Do. 750 p. p. m.	127	288.7
Do. 1,550 p. p. m.	150	340 9
Do. 75 p. p. m. + 305 p. p. m. NaCl.	56	127.3
Do. 75 p. p. m. + 305 p. p. m. $CaCl_2$.	60	136.4

TABLE IV.

Data for Experiment XII.

Solution Used on Sand.	Transpiration for 2 Days.	
	In Grs.	Relative.
Nutrient solution, 75 p. p. m.	24	100
Do. 750 p. p. m.	50	208.3
Do. 75 p. p. m. + 675 p. p. m. NaCl.	32	133.3
Do. 75 p. p. m. + 675 p. p. m. $CaSO_4$.	31	129.2
Do. 75 p. p. m. + 675 p. p. m. Na_2HPO_4.	35	145.8

The data of experiments I. to VI. of the present paper (Table I.) show that the average growth in the nutrient solution of 75 parts per million is 161.6, and for the same solution of a concentration of 155 parts per million the average growth is 188.7. On the average, the latter concentration is the optimum for wheat growth as nearly as this can be approximated from the series, so that the acceleration which it is possible to obtain by increase in concentration is 188.7 — 161.6/161.6, or 16.8 per cent. Considering only the four experiments which showed an increase in favor of the stronger of these two concentrations (experiments I., II., III. and VI.), this average is, of course, much higher, being 27 per cent., or very nearly the same as the increase obtained by treating the weaker solution with ferric hydrate, and considerably less than that obtained with carbon. Thus we are confronted with a case where two entirely different treatments bring about the same effect upon the plant. It is practically proved that the insoluble bodies have their effect here by removing from solution the deleterious excretions of the plant roots. The effect of increase in concentration may be explained by one or more of the three following hypotheses: The higher concentration may make the plant more resistant to the poisons; it may actually prevent the excretion of such poisons from the roots; or with higher concentration of salts the poisons themselves may be altered so as to lose their toxic properties. Which of these explanations is correct can not be decided now, but it is at any rate very clear that the acceleration observed has no direct connection with the nutrient value of the medium.

In soil or sand cultures the effect of concentration is known to be very different from that in water cultures; for instance, the concentration best suited to wheat in water culture is about 300 parts per million of nutrient solution, while in sand it lies in the vicinity of 2,500 parts per million. To investigate the question whether the effect of strength of solution in sand is due to physical concentration or to chemical conditions of nutriment, several series of sand cultures were carried out.

Pure quartz sand was placed in paraffined wire baskets of the form described in Bulletin No. 23 of this bureau, and the hardened paraffin at the bottom was punctured with pin holes to allow free drainage. In experiment X. six wheat plants were grown in these baskets for sixteen days, the sand being flooded daily with nutrient solutions of concentrations of 15, 75, 750 and 1,550 parts per million of total salts, respectively, while the excess of solution was allowed to drain out

through the bottom. In this way the plants were kept abundantly supplied with fresh solution. At the end of this period the differences in growth were very marked, there being a gradual increase in growth from those flooded with the weakest to those flooded with the strongest solution, the latter culture being by far the best of the series. This experiment was repeated as experiment XI., and in addition the solution of 75 parts per million was increased in concentration by the addition of 305 parts per million of sodium chloride and also of an equal amount of calcium chloride. The baskets were flooded with the solution daily for 18 days, at the end of which time they were sealed over the top with paper and paraffin to prevent evaporation from the surface of the sand, a small opening being left for the stems. The transpirations were then taken for two days and are given in Table III., together with the relative figures obtained by considering the transpiration of the first culture as 100. The figures are relatively proportional to the size of the plants at this time.

Here the same gradation of growth is apparent in the series of different concentrations of nutrient solution as was observed in experiment XI. Furthermore, addition of either sodium chloride or calcium chloride produces a marked increase in growth. This test was repeated as experiment XII., this time taking as controls the nutrient solution in concentrations of 75 and 750 parts per million and increasing the concentration of separate portions of the weaker of these by addition of 675 parts per million of sodium chloride, of calcium sulphate and of sodium phosphate, respectively. The cultures were treated in the same manner as in experiment XI. until the twenty-seventh day, after which they were sealed and weighed. The transpiration for two days is given in Table IV., together with relative figures obtained in the usual manner.

From the last three experiments it appears that in quartz sand as well as in a free solution the concentration of dissolved salts is a factor in determining plant growth, independently of any changes in the nutrient value of the medium. This may be so in ordinary soils, as well, although of course the problem here is complicated by the presence of undissolved nutrient materials in the soil. Ferric hydrate and carbon black have the same beneficial effect when mixed into many infertile soils as has been described for nutrient solutions, so that it appears that the above-mentioned hypotheses regarding toxic materials may be applied here also.

For many years experiment station workers have been studying the problem of the replacement of potassium by sodium compounds in commercial fertilizers. Marked increases in crop yields have been obtained by the addition of sodium chloride to soils receiving only a small amount of potassium. From the experiments here described it appears that this increase in yield may not at all be directly connected with any change in the nutritive content of the soil.

J. F. Breazeale.

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THE CLASSIFICATION OF THE ORDOVICIAN ROCKS OF OHIO AND INDIANA.

A more detailed study of the great mass of strata included in the Cincinnatian series of the Ordovician rocks of Ohio, Indiana and Kentucky makes necessary the classification of these strata into divisions and subdivisions of the series. This service was rendered by Mr. John M. Nickles in his papers on the Geology of Cincinnati[1] and on the Richmond group in Ohio and Indiana.[2]

In the twenty-eighth annual report of the Indiana Geological Survey, published in 1903, the classification proposed by Nickles was adopted without change. Since the publication of this report, however, several changes in the nomenclature have seemed advisable. Some of these are due to the practise, which recently has become more general, of adopting distinct names for formations which formerly were considered approximately identical, whenever a study of their fossil faunas indicates that these formations were deposited in zoolog-

[1] *Journal Cincinnati Soc. Nat. Hist.*, 1902.
[2] *Am. Geol.*, 1903.

ical provinces essentially distinct. Now, a study of the fossil lists given by Nickles in his 'Geology of Cincinnati' indicates that the rocks at Cincinnati identified as Lorraine and Utica contain faunas so different from the typical Lorraine and Utica faunas of New York as to warrant the application of the principle above stated. For this reason the name *Maysville* is here suggested for the strata at Cincinnati hitherto identified as Lorraine. Along the railroad south of Maysville, Kentucky, from the first cut a little over a mile from town to the overhead bridge a mile north of Summit a magnificent series of exposures gives a complete section of all the subdivisions of the Maysville division, from the Mount Hope bed to the top of the bed formerly known as Warren. The name *Eden,* well defined by Orton in the first volume of the 'Geology of Ohio,' published in 1873, is revived for the strata which in the 'Geology of Cincinnati' are identified as Utica. Whether the clay bed, four or five feet thick, containing *Triarthrus becki,* at the base of the Eden division should be included in the Eden or not, is a question which requires further study. On the supposition that *Triarthrus becki* proves this clay layer to be of the same age as the Utica of New York, and that the Eden beds represent a later stage of deposition than the Utica of New York, the clay bed containing *Triarthrus becki* should be excluded from the Eden division. The writer, however, is not prepared to assert that the clay bed in question is the only representative at Cincinnati of the considerable thickness of black shales struck in the gas and oil wells of northern Ohio, and there identified as Utica. Nevertheless, it may be convenient to have a name for the *Triarthrus* horizon, and the name *Fulton layer* is here adopted, not because Fulton presents the best exposures, but because the names of the other localities at which this horizon occurs are already in use. Fulton was formerly a suburb of Cincinnati, and now forms part of the First Ward.[3] The other localities are in Taylors Creek, east of Newport; at the quarry along the railroad, about half a mile southeast of New Richmond, Ky.; and at Point Pleasant, O.

[3] 'Geology of Cincinnati,' p. 55.

Several changes in nomenclature appear advisable on account of a second practise, which has become more imperative since the publication by Weeks, in 1902, of the 'North American Geologic Formation Names.' This practise opposes the use of the same name for different formations, even if widely separated geographically and belonging to widely different geological ages. In consequence the name *Saluda* was suggested in a paper on the Cincinnati geanticline in southern Kentucky[4] in place of Madison, and now the name ***Arnheim*** is proposed in place of Warren. This has the additional advantage of leading the investigator to a type locality where the characteristics of the formation can be well studied. Arnheim is a little village seven miles northeast of Georgetown in Brown County, O., and several miles east of the railroad from Georgetown to Sardinia, but is easily reached by good pikes. It makes up by the excellency of the exposures for its somewhat inconvenient location. The section begins a short distance south of town, at the Blue Banks, the first steep exposure along Straight Creek. Here the base of the Waynesville bed is twenty-five feet above the level of the creek, and the top of the Arnheim bed consists of the nodular clay layer so characteristic of the exposures of this bed in Warren County, O. The base of the Arnheim bed is a considerable distance down the stream, where it rests upon the top of the Mount Auburn bed, which contains an abundance of *Platystrophia lynx* at the top. The thickness of the Arnheim bed is estimated approximately at sixty-three feet.

In attempting to trace the Liberty and Whitewater beds in Indiana, the writer found great difficulty in separating these beds at any considerable distance from the type localities; for instance, at Madison, Indiana, and thence southward. For this reason it has seemed convenient to have a name for this part of the Richmond section, the Middle Richmond, when it is not found practicable readily to distinguish the smaller divisions. The name *Versailles bed* is here proposed. Along the

[4] *Am. Geol.*, 1902.

road at the northern edge of Versailles, Ind., both the *Hebertella insculpta* horizon, at the base of the Versailles bed, and the *Columnaria* layer, immediately below the massive *Tetradium* layer, at the base of the Madison bed, are well exposed.[5]

The name *Garrard,* introduced by Campbell, in Folio No. 46, of the 'Geological Atlas of the United States,' 1898, may be used not only for the comparatively unfossiliferous Upper Eden beds of central Kentucky, but also for the equivalent, often richly fossiliferous, beds farther north.

Finally, the reference of the beds underlying the Eden opposite Warsaw, Ky., on the Indiana side of the Ohio River, to the Point Pleasant beds of Orton may be asserted with greater confidence, since these lower beds have been studied along the Ohio River as far east as Stony Point, a mile and a half east of Higginsport. At Point Pleasant, O., a short distance west of the town, the base of the clay layer with *Triarthrus becki* occurs 113 feet above the level of the river. From this level downward almost 50 feet of rock are quarried. Between the level of the river road and the river, a vertical distance of fifty-five feet, the exposures are very poor, and no quarrying operations are carried on here. It is very evident that Professor Orton referred to the quarried rocks, when proposing the name Point Pleasant beds. As late as 1893, in volume VII. of the 'Geological Survey of Ohio,' p. 4, he states distinctly that the Trenton limestone is seen only in the Point Pleasant quarries, if at all in the state. Professor Orton did not regard the quarried rocks at Point Pleasant as equivalent to the Lower or River quarry beds opposite Cincinnati, although both lie directly below the *Triarthrus becki* layer, and in this he has been followed by other investigators. The present writer, on the contrary, after an examination of all the exposures along the Ohio River, has come to the opposite conclusion. The observations which lead to this result are chiefly the following: The most characteristic and unbiquitous fossil in these beds all along the Ohio River is *Eridotrypa briareus.* Even if this fossil eventually should be found in the Lexington limestone, it can not be common there, since so far it has not been detected at all. In the next place, *Trinucleus concentricus* is found in the upper part of these beds at many localities. It is present opposite Warsaw; opposite Cincinnati it was detected as low as eighteen feet below the top of the heavy limestone beneath the Eden section. At Point Pleasant it occurs in the upper part of the section. Whatever its range may be elsewhere, along the Ohio River it does not extend below the upper part of the rocks here identified as Point Pleasant beds. It certainly never has been found in rocks known to be of Lexington age. Again, the rocks are very much alike lithologically. This usually does not appear where the rocks have been quarried, but where much weathered along the hillsides, the similarity of the rocks at Point Pleasant and at Cincinnati often is very striking. For instance, on the hillside southwest of the railroad trestle at Foster, Ky., near railroad level, the dense, fine-grained limestones with numerous cross-sections of gastropods, and the coarse-grained, more crinoidal limestones, often wave-marked along the top, have an appearance very much like the long-exposed rocks in the Mohawkian section opposite Cincinnati. These features are not presented by the Lexington rocks in central Kentucky.

The total thickness of rocks to be included in the Point Pleasant beds, if this name is to

Series.	Divisions.	Beds.
Cincinnatian.	Richmond.	Saluda. Versailles. Waynesville.
	Maysville.	Arnheim. Mount Auburn. Corryville. Bellevue. Fairmount. Mount Hope.
	Eden.	Garrard. Middle Eden. Lower Eden (Fulton layer).
Mohawkian.	(Upper Beds.)	Point Pleasant. Lexington (top only).

[5] *Am. Journ. of Sci.,* 1904, p. 329.

be retained, probably should be approximately one hundred feet. Below this level at Moscow, Carnestown, Foster and elsewhere, rocks appear which contain *Callopora multitabulata*, a characteristic Lexington fossil, identified by Bassler.

With the modifications suggested in the preceding lines, the Ordovician sections in Ohio and Indiana, and in the adjacent parts of Kentucky, may be classified as on p. 151.

Aug. F. Foerste.

Dayton, Ohio.

RECENT WORK OF THE WISCONSIN ARCHEOLOGICAL SOCIETY.

The recent work of the Wisconsin Archeological Society shows that it is steadily increasing in strength. It has succeeded in having passed by the state legislature bill No. 195 A, which was introduced early in February of this year and approved June 10.

The passage of this bill is notable, since it is the first archeological measure of the state government, being the only one to receive the unanimous support of the legislature. Many such bills have been introduced during the past twenty-five years, but most of them never left the committee in which they were introduced. Every member of the society has given this legislation his hearty support. The officers profited by the fate of the several archeological bills introduced in the legislature of their sister state, Michigan, and sought advice from those interested in archeological work in that state. Profiting from the plans for work in Michigan, they have not only developed the plans, but have actually put many of them in force. They have also adopted some entirely new methods of securing information and of popularizing and disseminating it.

The officers of the society are confident that the bill is only a beginning with the popular government. By this state aid their work will be facilitated, for under the provisions of the bill all the bulletins of the society will be printed by the state. Its results, being thus brought before the citizens, will no doubt prove the right of the society to further aid from the state in the near future.

The bill, which is an amendment to section 341, of the statutes of 1898, provides that "There shall be printed by the state printer bimonthly, in pamphlet form, 1,500 copies of the transactions of the Wisconsin Archeological Society, on good quality book paper, uniform in style with the volumes heretofore published by said society, including necessary illustrations, not to exceed 25 pages for each copy. . . . This act shall take effect and be in force from and after its passage and publication." One hundred and thirty-three free copies of each issue are to be presented to the Wisconsin Free Library Commission for distribution among its traveling libraries.

One of the first publications to be printed under the provisions of the state printing grant will be a monograph on 'The Aboriginal Pipes of Wisconsin,' by the president of the society, Mr. George A. West. Mr. West has devoted time and money for years in securing the material upon which this monograph is based.

The society also contemplates the publication of catalogues of all the archeological specimens found in Wisconsin, including especially those now kept in institutions outside the state, in order that students of the archeology of Wisconsin may know what material is available and where it is.

The standing committee on landmarks of the Wisconsin Federation of Women's Clubs is cooperating with the Wisconsin Archeological Society. Miss Julia A. Lapham, daughter of the late Dr. Lapham, one of the greatest authorities on the archeology of Wisconsin, is chairman of this committee, which has sent circulars to the Women's Clubs of the state. These circulars ask for a report on the work done by each club in response to a general order urging the study of local history and archeology and that local action be taken to preserve ancient landmarks, including Indian mounds, and also that a Landmarks Day be arranged in each year's program. Records are sought of Indian trails, old military and territorial roads, trading posts, first buildings and their purposes, portages, ferries, ancient village sites, mounds, ancient 'garden-beds'

and corn hills, traces of all of which are rapidly being destroyed. A plea is made that these at least be recorded and when possible photographed, marked and preserved. Every club is urged to investigate the meaning of the names of the cities, towns, counties and other places with any traditions regarding them.

Copies of all records prepared in response to these pleas, and all photographs, are requested to be sent in to the committee to be filed in the central office or bureau of records of the society.

The members of the society and its friends in Wisconsin having been relieved of the financial burden of the publication of the archeological bulletin, and having sufficiently supplemented the fund thus saved, are now able to provide funds to employ a manager for the work of the society throughout the state. This has made it possible for Mr. Charles E. Brown to resign from the staff of the Milwaukee Public Museum and to assume full direction of the central office of records and all field work in the state. He is at present systematizing and extending the work, much of his time being devoted to interesting local business men and to securing funds and memberships, as well as to the direction of exploration and the preservation of notes, photographs, maps and specimens.

Mr. Brown served the museum for seven years, and is specially fitted by his training and his careful disposition for the task of directing the work of the local society. He edited the four volumes of the bulletin which appeared before state aid was secured, is a founder of the American Anthropological Association and author of many papers on the archeology of Wisconsin.

The society has been incorporated under the laws of Wisconsin and numbers among its members hundreds of workers, some of them in each part of the state. It has already been able to preserve mounds at Waukesha, West Allis and other places and the archeological survey of the state has been completed in several counties. Public meetings are held and lectures are provided by the society which are intended especially for the public. For several years Beloit College has been offering courses in American archeology and history under the direction of Dr. George L. Collie.

The society is now establishing a central office and bureau of records. Its researches are being carried on in many parts of the state by more workers than were ever available before. The large number of these colaborers is the result of the patient encouragement and guidance on the part of the society during the past years. Mr. Brown will himself be in the field in charge of an exploring party this season.

Several museums, libraries and colleges have been thus far selected as repositories for collections, but the plans of the society are that many more widely distributed places shall become such. An effort is being made to prevent the manufacture and traffic in counterfeit specimens, and to prevent collections or even specimens from leaving the state; but we believe that no sincere member of the society will do anything to prevent the great museums of our country and the world from securing representative educational collections or from carrying on research in the state. It is even our belief that the members will welcome cooperation in exploration, provided the work is properly done, the results are published and the specimens are kept available for students in a public institution. For synoptic collections to illustrate known facts, no doubt the society will eventually supply specimens from its duplicates.

Local collectors are being influenced to deposit their collections in their near-by educational institutions, but no effort is apparently being made to deprive any section of the state of collections in order to build up one great museum. This may cause students to spend some time in traveling from one museum to another, but it certainly stimulates local interest.

The Schumacher collection, consisting of a large series of objects from the Green Bay region, has been deposited by its owner, Mr. J. P. Schumacher, in the Kellogg Library at Green Bay, Wis.

The West collection of pipes, many of which are from Wisconsin, will be presented in time

to some Wisconsin institution. It comprises many hundreds of specimens representing every period and type from the primitive pebble and tubular forms to the pottery, lead and iron pipes of early historic times. It is unsurpassed by any private collection in its richness in monitor, disk, Micmac and Siouan pipes.

The James G. Pickett collection of Wisconsin implements has been purchased and presented to the Oshkosh Public Library through the interest of Mrs. Leander Choate. This collection consists of specimens collected in the Winnebago Lake region, which is remarkably rich in archeological material.

The collection of Wisconsin antiquities brought together by the late authority on Wisconsin archeology, Dr. I. A. Lapham, will soon find a home in the Milwaukee-Downer College, to which it will be presented by the Wisconsin Archeological Society to form there the nucleus of another repository for Wisconsin material.

The W. H. Elkey collection of nearly 6,000 selected Wisconsin implements made of stone and copper was purchased in June at the suggestion of the society by Mr. Frank A. Logan, of Chicago. Mr. Logan is a member of the society and secured the collection for the Logan Museum of Archeology at Beloit College, of Beloit, Wis. This is the second great Wisconsin collection which Mr. Logan has added to this museum during the past two years. Both Mr. Logan and Dr. George L. Collie, dean of the college and curator of the museum, are determined to make this museum the home of one of the greatest of the archeological collections to be made from the Great Lake region.

These are only a few of a large number of archeological collections from Wisconsin, all of them valuable, which the Wisconsin Archeological Society is determined to have secured for the state and students of its archeology. This may be done by deposit in local colleges, museums and institutions or by purchase and donation to such repositories. A large number of local institutions, in fact a majority of them, which have been strangely apathetic in the past, are now cooperating with the society in all these efforts.

In order to bring the work of the society before the general public and to interest them in the educational and historical value of the archeological material found in Wisconsin, the society will install at the September meeting of the state fair at State Fair Park, West Allis, an exhibit intended to illustrate by means of objects, photographs, maps, charts and models the chief archeological features of various sections of the state. For this purpose photographs are being taken or secured of mounds, specimens and others of the most popular and instructive antiquities of the state. Loans of specimens for the purpose are also being made to the society by its members in all parts of Wisconsin.

A group of mounds, the restoration and preservation of which were brought about by the society several years ago, is located on the fair grounds. The attention of visitors will be directed to this group, which will prove a wholesome object lesson to all who come from parts of the state where there are mounds capable of being so preserved. It will be remembered that such is the case in practically every part of the state.

Public lectures will be given at the fair by various prominent members of the society and literature will be distributed freely. In its undertakings in connection with the fair the society is receiving the assistance of the state board of agriculture.

The archeologists of Wisconsin began to take an active interest in the archeology of their state and to cooperate with each other only a few years ago. Previous to that time there were but few workers and no cooperation. They have worked patiently, perfecting an organization largely due to the efforts of Mr. Charles E. Brown, have sought advice freely and have adopted the best plans offered them. They have developed such plans and made original schemes of their own. They have never forgotten that their chief aim was research, while they have persistently popularized the work in a way that has built up a strong public opinion in their favor and a

goodly constituency. They are glad to teach what they have learned by research to any one who cares to learn. They are preserving archeological sites, specimens and records for future research and for educational purposes. Practically all this result has been secured in a period of less than five years.

HARLAN I. SMITH.
AMERICAN MUSEUM OF NATURAL HISTORY.

NATURE AND MAN.[1]

PROFESSOR LANKESTER in his Romanes lecture began by a statement of the theory of evolution, directing attention to unwarranted inferences commonly drawn by clever writers unacquainted with the study of nature. He described how the change in the character of the struggle for existence, possibly in the Lower Miocene period, which favored an increase in the size of the brain in the great mammals and the horse, probably became most important in the development of man. The progress of man cut him off from the general operation of the law of natural selection as it had worked until he appeared, and he acquired knowledge, reason, self-consciousness and will, so that 'survival of the fittest,' when applied to man, came to have a meaning quite different from what it had when applied to other creatures. Thus man can control nature, and the 'nature searchers,' the founders of the Royal Society and their followers, have placed boundless power in the hands of mankind, and enabled man to arrive at spiritual emancipation and freedom of thought. But the leaders of human activity at present still attach little or no importance to the study of nature. They ignore the penalties that rebellious man must pay if he fails to continue his study and acquire greater and greater control of nature.

Professor Lankester did not dwell upon the possible material loss to our empire which may result from neglect of natural science; he looks at the matter as a citizen of the world, as a man who sees that within some time, it may be only 100 years, it may be 500 years, man must solve many new problems if he is to continue his progress and avert a return to nature's terrible method of selecting the fittest. It seems to us that this aspect of the question has never been fully dealt with before. Throughout Huxley's later writings the certainty of a return to nature's method is always to be felt. Professor Lankester has faith in man's power to solve those problems.

[1] From *Nature*.

The dangerous delay now so evident is due to the want of nature knowledge in the general population, so that the responsible administrators of government are suffered to remain ignorant of their duties. Professor Lankester shows that it is peculiarly in the power of such universities as Oxford and Cambridge, which are greatly free from government control, to establish a quite different state of things from that which now obtains in England. He says:

> The world has seen with admiration and astonishment the entire people of Japan follow the example of its governing class in the almost sudden adoption of the knowledge and control of nature as the purpose of national education and the guide of state administration. It is possible that in a less rapid and startling manner our old universities may, at no distant date, influence the intellectual life of the more fortunate of our fellow citizens, and consequently of the entire community.

Considering Oxford more particularly, and speaking for others as well as himself, he says:

> The University of Oxford by its present action in regard to the choice and direction of subjects of study is exercising an injurious influence upon the education of the country, and especially upon the education of those who will hereafter occupy positions of influence, and will largely determine both the action of the state and the education and opinions of those who will in turn succeed them.

As to Greek and Latin studies, he says:

> We have come to the conclusion that this form of education is a mistaken and injurious one. We desire to make the chief subject of education both in school and in college a knowledge of nature as set forth in the sciences which are spoken of as physics, chemistry, geology and biology. We think that all education should consist in the first place of this kind of knowledge, on account of its commanding importance both to the individual and to the community. We think that every man of even a moderate amount of education should have acquired a sufficient knowledge of these sub-

jects to enable him at any rate to appreciate their value, and to take an interest in their progress and application to human life.

He points out that it is only in the last hundred years that the dogma of compulsory Greek and the value of what is now called a classical education has been promulgated. Previously, Latin was learnt because all the results of the studies of natural philosophers were in that language.

It is evident that Professor Lankester includes in his study of nature the study of intellectual and emotional man through history, biography, novels and poetry, but we think that he made a tactical mistake when he neglected to state this clearly. It seems to us that besides the study of nature, the most important thing in a child's education is to make him fond of reading in his own language, for this leads to a future power to make use of books and self-education for the rest of his life. When Professor Lankester doubts the value of the study of history he is evidently doubting the value of that study as carried on at Oxford, and surely no person who has read the scathing criticism of Professor Firth will disagree with him. When he speaks of a reform being possible, it may be that he is taking into account a movement of which but little is known outside Oxford itself, the growing indignation of the average undergraduate at being made to pay extravagant sums of money for tuition which is mischievous.

The readers of *Nature* are well acquainted with the views put forward in this address. Huxley and many others, dwelling, perhaps, more upon material loss to our empire, have published them over and over again, but we do not think that anybody has ever presented them with so much grace of style or so much of an endeavor to secure the good-will of his audience as Professor Lankester. But, alas! we fear that this fine address will share the fate of many others!

When, thirty-three years ago, Japan began her new career, there were a few people like Ito clever enough to see and say that the study of ancient classics alone, to the neglect of the study of nature, meant ruin to the country; but such ideas would never have been adopted had not Japan been in deadly peril. All the nations of Europe bullied and insulted her, and it was only their mutual jealousies which saved her from complete subjugation. In the presence of that peril the pedants held their peace, and everybody saw the necessity for an immediate, radical reform. In time nature was studied by every child in Japan, and in consequence scientific methods of thinking and acting have permeated the whole nation. All ancient and modern European literature is open to the Japanese who knows English, and English is the one language other than Japanese which every cultured man must know. In the matter of self-protection, any one can see the result. Because the Japanese have studied nature their scientific officers and men have marched or sailed to victory in every engagement; their statesmen will do exactly what is best for Japan in the negotiations for peace; their country will quietly take its place as one of the first-class powers of the world, and every person who knows anything about Japan is quite sure that ambitious, wrong-headed schemes of conquest are altogether impossible to the scientific minds of the Japanese.

If Japan had not been in great danger we know that she would not have taken to nature-study, and some of us think that it may need a state of danger in England to produce the necessary desire for reform. The South African muddle was worried through, and almost everybody seems to think that all such muddles may also be worried through, but some of us think that we may not always be so lucky. Danger is close enough even now, and we can only hope that if it becomes great it may grow slowly enough to let us learn something from the object-lesson which is being given us day by day in the news from Russia and the far east.

Fain would we hope that Oxford will pay attention to what has been said by one whom some of us regard as her cleverest son; but, alas! we have no such hope. Oh, Shade of Clough, how can we help saying that 'the

struggle naught availeth' when your own best admirers seem unable to think for themselves?

JOHN PERRY.

SCIENTIFIC NOTES AND NEWS.

DR. WILLIAM J. MAYO, surgeon of the St. Mary's Hospital, Rochester, Minn., has been elected president of the American Medical Association.

DR. WILLIAM H. NICHOLS, of New York, gave the presidential address before the Society of Chemical Industry at its general meeting in London on July 10. Dr. Edward Divers, F.R.S., was elected president of the society for the ensuing year.

FREDERIC S. LEE, PH.D., professor of physiology in Columbia University; Martin H. Fischer, Ph.D., assistant professor of physiology in the University of California, and George T. Kemp, Ph.D., professor of physiology in the University of Illinois, have been elected associate members of the American Medical Association.

THE *Révue de médecine et d'hygiene tropicales* announces that Dr. Ch. Wardell Stiles, of the Public Health and Marine Hospital Service, has been elected an honorary member of the Société de Médecine et d'Hygiène Tropicales of Paris, France.

DR. GEORGE T. MOORE, physiologist and algologist, in charge of the laboratory of plant physiology of the Department of Agriculture, has resigned.

DR. GISBERT KAPP, who has accepted a professorship in electrical engineering at the University of Birmingham, has resigned as general secretary of the German Association of Electrical Engineers and as editor of the *Elektrotechnische Zeitschrift*. His successor as general secretary is Dr. Georg Dettmar, and his successor as editor of the *Elektrotechnische Zeitschrift* is Dr. E. C. Zehme.

WE learn from the *Bulletin of the American Mathematical Society* that Professor H. Taber, of Clark University; Professor H. F. Blichfeldt, of Stanford University, and Professor W. D. Cairns, of Oberlin College, will spend next year at European universities.

M. M. J. DYBOWSKI, French inspector general of agriculture for the colonies, has been made an officer of the French legion of honor.

ON the occasion of the recent celebration of the fourth centenary of the Royal College of Surgeons, Edinburgh, the honorary fellowship of the college was conferred upon the following: Professors Anton, Freiherr von Eiselberg and Ernst Fuchs, Vienna; Professor Sylvester Saxtough, Copenhagen; Professor Felix Guyon Just Lucas Camponnière, Paul Segond and Louis Felix Terrier, Paris; Professor à Poucet, Lyons; Professors Ernst von Bergmann and Franz König, Berlin; Professor August Bier, Bonn; Professor Vincenz Czerny, Heidelberg; Professor Francesco Duranti, Rome; Baron Yosuzumi Saneyoshi, Japanese navy; Maxim Semenovic Subbotin, chief of the surgical clinic, Military Hospital, St. Petersburg; Professor Lennauder, Upsala; Professor Kronlein, Zürich; Professors William Stewart Halstead and Howard Kelly, Baltimore; Professor Keen, Philadelphia; Dr. William J. Mayo, Minnesota; Professor Charles McBurney, Columbia University, and Professor J. C. Warren, Harvard University.

AT the recent commencement of Amherst College the degree of master of arts was conferred by President Harris on Mr. Lundin. He said: "Carl Axel Robert Lundin, scientific expert in cutting and fashioning glasses of great telescopes. He has done important work on the large objectives of Russia, of the Lick and Yerkes observatories, and lately on the 18-inch objective of the Amherst College observatory, which is wholly his work. In 1854 Amherst conferred the degree of master of arts on Alvan Clark, who had built our first telescope. The same degree, for a similar service, is conferred on his successor, who has kept pace with the progress of astronomical science."

THE seventieth birthday of Professor G. Merkel was celebrated at Nuremberg, on June 29. He was presented with a *Festschrift*, and with a portrait bust by his former students and the Erlangen medical faculty.

DR. SWALE VINCENT, Winnipeg, professor of physiology in the medical faculty of the

University of Manitoba, has been invited by the University of London to deliver a course of lectures on 'The Ductless Glands.'

THE American Medical Association has taken steps for the erection of a suitable memorial to Dr. N. S. Davis, who is regarded as the founder of the association.

THE committee appointed on March 25, 1873, to consider the steps to be taken to raise a memorial at Cambridge to the late Professor Sedgwick has issued a final balance-sheet with a list of subscribers. The receipts were: Subscriptions for the building, £10,651 0s. 6d.; for the statue of the professor, £506 1s.; interest on deposit, £811 19s. 10d.; dividends, £13,714 1s. 3d.; profit on sale of investments, £1,769 19s. 9d.; total, £27,453 2s. 4d. The payments were: Printing, advertising, etc., £186 14s. 7d.; university for the building, £26,125; Mr. Onslow Ford for statue, £1,050; balance in hand, £91 7s. 9d., which has been paid over to the university financial board.

A TABLET was unveiled on July 14, by Signor G. Marconi, on the house in which Sir Humphry Davy once lived at Clifton, Bristol.

DR. J. LATCHENBERG, professor of physiology in the veterinary school of Vienna, died on June 21, at the age of fifty-seven years.

THE death is announced of Mr. Charles Moore, director of the Sydney Botanical Gardens, at the age of eighty-six years.

THERE will be civil service examination on August 16 and 17 to fill the position of physical chemist in the government laboratories at Manila, at a salary of $1,800 a year.

OWING to the occurrence of several cases of hydrophobia in Penang, four of which have already ended in death, Leong Fee, the Chinese consul, has made an offer to the British government to build and equip a Pasteur institute for the Straits Settlements and the neighboring regions.

DR. E. G. GADE has presented his native city of Bergen, Norway, with $30,000 to equip and support a laboratory for pathologic anatomy.

THE Bressa prize of the Turin Academy of Sciences will be awarded at the end of the present year for the most important work in the science during the preceding three years. The value of this prize is about $2,000.

DESPATCHES to the daily papers state that German astronomers are making unusual preparations for the observation of the forthcoming total eclipse of the sun. The Hamburg Observatory will send an expedition to Algiers, which will take an extensive series of observations, giving special attention to electrical phenomena. Photographs of the sky adjacent to the sun will be taken in the hope of discovering a planet within the orbit of Mercury. The observatories at Potsdam and Göttingen will send astronomers to Spain and Algiers for observations. The Prussian Meteorological Observatory at Potsdam is sending an expedition to Burgos, Spain, to study atmospheric and electrical phenomena the week before and the week after the eclipse.

AT the meeting of the International Zoological Congress, to be held in Boston in 1907 under the presidency of Mr. Alexander Agassiz, the prize founded by Emperor Nicholas II. will be awarded. The subject is new experimental researches on hybrids. The researches which may be in manuscript or printed after this announcement must be sent before June 1, 1907, to Professor R. Blanchard, Boulevard St. Germain, 226. The papers must, it appears, be written in French, or be accompanied by an abstract in French.

THERE were about 600 botanists present at the International Congress held at Vienna, from June 11 to 18. The third congress will be held at Brussels in 1910.

IN connection with the present visit of the British Association to Rhodesia, the British South African Company have issued a special set of postage stamps, the design on which represents a view of the Victoria Falls. This issue will also serve to commemorate the formal opening, during the British Association's visit to the falls, of the bridge across the Zambesi River, one of the greatest engineering marvels of modern times, and a most important link in the Cape to Cairo railway.

THE American Medical Association will meet next year at Boston at a time to be sub-

sequently determined. At the recent Portland meeting there was an attendance of 1,714 members. The association authorized the publication of a medical directory of the country and the purchase as the basis for it of the 'Standard Directory.' This national medical directory is to contain an abbreviated biography of all physicians of the United States. Among other topics taken up by the house of delegates was the exclusion of advertisements of nostrums from the journal of the association and the question of incorporation by congress. The American Medical Association has a large budget, especially in connection with its weekly journal, the publication expenses last year amounting to $181,298.

A MEETING was held at Toronto, on July 13, for the purpose of extending a formal invitation to the British Medical Association to meet in Toronto in 1906, indorsing the action of the Canadian Medical Association. Mr. I. H. Cameron was delegated to present this invitation at the approaching meeting of the association.

THE fourteenth International Congress of Americanists will be held at Quebec from September 10 to 15, 1906. Dr. Robert Bell, director of the Geological Survey of Canada, is president, and Dr. N. E. Dionne, librarian of the Legislative Assembly, Quebec, is secretary. The work of the congress will have reference to: (*a*) The native races of America, their origin, geographical distribution, history, physical characters, languages, civilization, mythology, religions, morals and habits. (*b*) The indigenous monuments and the archeology of America. (*c*) The history of the discovery and European occupancy of the New World. The meetings of the congress will take place in the legislative building. Details pertaining to receptions, entertainments and excursions will be given in a later announcement. It is probable, however, that after the close of the sessions of the congress, an excursion to Lake St. John, including a visit to a camp of Montagnais Indians of the region, will be organized. Excursions in the neighborhood of Quebec will be made during the week of the congress.

A PRELIMINARY program has been issued for the next International Medical Congress that will be held at Lisbon from April 19 to 26, 1906.

The Experiment Station Record states that an act recently passed by the state legislature of Massachusetts makes provision for the appointment of a superintendent for suppressing the gypsy and brown-tail moths, and outlines the duties of cities and towns in that connection and the conditions under which they may be reimbursed in part for the expense of suppression. The bill appropriates $300,000, of which $75,000 may be expended during the calendar year 1905, $150,000 during 1906, and the remaining $75,000, with any unexpended balances, up to May 1, 1907. An additional sum of $10,000 in each of the three years may be expended for experiments with parasites or natural enemies for destroying these moths. A. H. Kirkland, a graduate of the Massachusetts Agricultural College, and formerly connected with the gypsy-moth work of the state, has been appointed superintendent at a salary of $5,000 a year.

ACCORDING to an abstract in the *Geographical Magazine* the report for 1903–4 of the New Zealand Lands and Survey Department shows satisfactory progress in the way of mapping and defining areas and of the appropriation of the land. There were, in 1903–4, 2,813 new selections comprising over 1½ million areas, an increase of 35,279 on the area of land selected in 1902–3; 432 of the selections were less than 1 acre each, and 166 reached 1,000 acres and upwards, the average selection measuring 577 acres. Under the Village Settlement system there were, on March 31, 1904, 2,014 settlers holding 43,146 acres, an average of 21¼ acres each. In view of the great shrinkage of land inviting settlement and other drawbacks, the record of land operations must be accounted satisfactory. The gross total of milling timber on Crown lands is estimated at 21,000 million superficial feet, Nelson district heading the list with a volume of about 6,000 million superficial feet of all varieties, closely followed in order by Westland and Wellington. The Crown kauri timber in Auckland is found

to be below former estimates, and as there are about thirty-six kauri mills clearing 144 million superficial feet per annum, in eight years the colony's supply of kauri would be exhausted. However, the timber of the rimu, matai and totara forests in the north is now found far in excess of previous computations. The output of all the mills in the colony is estimated at 372 million superficial feet per annum, a rate which would clear away all the colony's timber in seventy years. On the other hand, over 6½ million trees were raised in the nurseries and plantations in 1903–4 as against 4 million in 1902–3. The total number of trees raised between 1896 and 1904, on an area now measuring 1,040½ acres, was 18,293,682. The prison-labor applied to tree-planting has proved every way profitable, notably in a moral sense, to the prisoners. The weight allowed to the claims of natural beauty may be gathered from the assignment of ample areas as scenic reserves. More particularly, in the highly picturesque south land it is proposed to preserve in native immunity no less than 2,772,440 acres, including the Sounds National Park of 2,500,000 acres. During 1903–4 triangulation continued more or less in abeyance owing to settlement requirements, but the surveyor-general urges the resumption of triangulation on a large scale. A full report of the magnetic work of the year is furnished by Mr. Skey. Particularly interesting is the reference to the joint work of the Hagley Park observatory and the Antarctic Expedition. Eight photographs of the most marked seismograms of the year are appended. In the northern part of the South Island magnetic work has been suspended since February, 1904. A further three months' work by one officer is all that is now needed to complete the magnetic survey of the colony, the results of which would be of so great value as well to navigation as to pure science. The comprehensive report deals also with temperature, rainfall, sanctuaries for animals and birds, etc. Besides maps and plans, there are numerous illustrations of scenery, flora, fauna, etc. The report of the minister of railways shows the railway mileage of New Zealand as 2,328.

UNIVERSITY AND EDUCATIONAL NEWS.

The cornerstone has been laid of the new engineering building of the University of Iowa, which is to be erected at a cost of $600,000.

The contract has been awarded for a new bacteriological building at the University of Minnesota. It will be built at once and will cost $100,000.

Mr. Simon Guggenheim has given $75,000 to the Colorado School of Mines at Denver. It will be used for the erection of an administration building.

The university benefaction fund for Cambridge University now amounts to about $400,000. The largest gift during the past year is one of $25,000 from Lord Rayleigh.

The Bates College corporation will ask from the Maine legislature a repeal of the charter which provides that the president of Bates College and a majority of the board of fellows and of the board of overseers shall be members of some church in the Free Baptist denomination. It is understood that this action is taken in order that the college may take advantage of the pensions of the Carnegie Foundation.

Two new fellowships have been created in the department of chemistry, Ohio State University, Columbus, Ohio. The holders of the fellowships will receive free tuition and $300. Applicants should apply at once to Professor William McPherson, Columbus, Ohio.

The council of the University of Liverpool has instituted a lectureship in experimental psychology. The work in psychology will, for the present, be carried on in the physiological laboratory.

Professor H. S. White, of Northwestern University, has been appointed professor of mathematics at Vassar College.

Mr. W. H. Watkinson, of the Glasgow and West of Scotland Technical College, has been appointed professor of engineering at the University of Liverpool.

SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

BIOLOGY AND MATHEMATICS.[1]

THAT which is most characteristic of the present epoch in the history of man is undoubtedly the vast and beneficent growth of science.

In things apart from science, other races at times long past may be compared to the most civilized people of to-day.

The lyric poetry of Sappho has never been equaled. The epic flavor of Homer, even after translation, comes down to us unsurpassed through the ages.

Dante, the voice of ten silent centuries, may wait another ten centuries before his medieval miracle of song finds its peer.

The Apollo Belvidere, the Venus of Milo, the Laocoon, are the glory of antique, the despair of modern sculpture. To mention oratory to a schoolboy is to recall Demosthenes and Cicero, even if he has never pictured Cæsar, that greatest of the sons of men, quelling the mutinous soldiery by his first word, or with outstretched arm, in Egypt's palace window, holding enthralled his raging enemies, gaining precious moments, *time,* the only thing he needed to enable him to crush them under his dominant intellect.

There is no need for multiplying examples. The one thing that gives the present generation its predominance is science.

All criticisms of life made before science had taken its present place, or attempting to ignore its prominence, are obsolete, as are of necessity any systems founded on pre-scientific or anti-scientific conceptions.

[1] Address before the Ohio Academy of Science.

Now the latest of the great sciences is biology, and it could be so widely interpreted as to include many of the others, for example, physiology, psychology, sociology; but chiefly it takes for itself the broad general beginnings.

These older sciences were really engaged upon narrow domains, narrow ramifications in the universe of biology; and the general has helped the preexistent special by giving the broader conceptions connoted by comparative physiology, comparative psychology, comparative sociology.

Since Wöhler, the distinction between organic and inorganic matter has become merely schematic; but the line drawn at life has resisted obliteration.

It is true that my friend Professor Herrera has said:

I conceive the human organism as a machine containing some five or six liters of blood employed in appropriating to itself the nutritious principles of food, absorbing oxygen, and carrying it to the nerve to make it vibrate by discharges of carbon dioxide.

Life is now to be defined as the result of the physicochemical action of protoplasmic currents, the cause of such currents being diffusion, heat and some other secondary factors.

But until some one sees such currents set up in some way differing from the natural transmission of preexistent life, a thing which no one at present even hopes for, the old boundary remains undisturbed.

If any benefit is obtainable from a physico-chemical nomenclature and notation, science will not object to their use.

Suppose, then, we put it in the boldest form, that biology is now engaged in the creation of an available representation of the activities and laws of activity of these wonderful protoplasmic currents.

The definition then would be something like this: Biology is the science created to give understanding and mastery of the protoplasmic activities on this earth; to make easy the explanation and description of such activities and the transmission of this mastery.

The association, the suggestion, is immediate:

Beyond the microtome, the microscope, the statistics of observation, of experiment, of what instrument of world-conquest must the new science avail herself? The answer is patent: of mathematics, that giant pincers of scientific logic which showed Newton the moon as simply a bigger apple trying to fall straight down on his head, flashed out in the mind of Adams the unseen planet Neptune, told Rayleigh that the chemists had always been breathing vast quantities of argon without knowing it, pointed to Mendelieev the places of unknown chemical elements, and through Helmholtz and his pupil Hertz has given us the Lenard rays, the Roentgen rays, radium itself, and wireless telegraphy based on Hertzian waves.

In mathematics, the part which is being recognized as pure deductive logic is ever greater. The residuum takes from biological advance itself new form and new statement.

After the questions, what are facts? what is reality? questions not to be answered either by biology or mathematics, there come, if we decide to retain as rough working hypotheses the expressions, fact, reality, subsequent questions, such as what then is a *geometric* fact, a *geometric* reality?

These latter questions involve a wrestling with primitive origins in physiological psychology, now entangled with metaphysical constructions, all being studied at present with help of the biologically given hypothesis of evolution.

To note the essential interrelation of biology and mathematics it is only needful to recall that evolution postulates a world independent of man, preceding man, and

teaches the production of man from lower biologic forms by wholly natural causes.

If this be so, then skipping the fundamental puzzle as to how a living thing gets any conscious knowledge, any subjective representation of that independent world, it remains of the very essence of the doctrine of evolution that man's knowledge of this independent world, having come by gradual betterment, trial, experiment, adaptation, and through imperfect instruments, for example, the eye, can not be metrically exact.

In the easiest measurements it is said we can not even with the best microscopes go beyond one one millionth of a meter; that is, we are limited to seven significant figures at most. What is the meaning then of the mathematics which, as in the case of the evaluation of π, has gone to seven hundred places of significant figures?

If then we are to hold to evolution, science must be a construction of the animal and human mind; for example, geometry is a system of theorems deduced in pure logical way from certain unprovable assumptions precreated by auto-active animal and human minds.

So also is biology. But here the assumptions are more fluctuating, and many of them are still on trial.

Since every science strives to characterize as to size, number, and, where possible, spatial relations, the phenomena of its domain, each has need of the ideas and methods of mathematics. One of the fundamental ideas of mathematics is the idea of variation, the variable, qualitative and quantitative variability.

When related quantities vary, one may vary arbitrarily. This is called the independent variable. Others may vary in dependence upon the first. Such are called dependent variables or functions of the independent variable. The change of the variables may be continuous or discontinuous. The blind prejudice for the assumption of continuity is so profound as to be unconscious.

But if biologists did but know it, the characteristics, peculiarities and methods of investigation for continuous functions differ essentially from those for discontinuous functions.

Our calculus assumed continuity in all its functions, and also that differentiability was a necessary consequence of this continuity.

Lobachevski, the creator of the non-Euclidean geometry, emphasized the distinction between continuity and differentiability, therein also being half a century in advance of his contemporaries.

The mathematicians of the eighteenth century did not touch the question of the relation between continuity and differentiability, presuming silently that every continuous function is *eo ipso* a function having a derivative.

Ampère tried to prove this position, but his proof lacked cogency. The question about the relation between continuity and differentiability awoke general attention between 1870 and 1880, when Weierstrass gave an example of a function continuous within a certain interval and at the same time having no definite derivative within this interval (non-differentiable).

Meanwhile, Lobachevski, already in the thirties, showed the necessity of distinguishing the 'changing gradually' (in our terminology, continuity) of a function and its 'unbrokenness' (now, differentiability).

With especial precision did he formulate this difference in his Russian memoir of 1835: 'A Method for Ascertaining the Convergence,' etc.

A function changes gradually when its increment diminishes to zero together with the increment of the independent variable. A function is unbroken if the ratio of these two increments, as they diminish, goes over insensibly into a new

function, which consequently will be a differential coefficient. Integrals must always be so divided into intervals that the elements under each integral sign always change gradually and remain unbroken.

In more detail Lobachevski treated this question in his work, 'On the Convergence of Trigonometric Series,' in which are also contained very interesting general considerations on functions.

It seems, he writes, that we can not doubt the truth that everything in the world can be represented by numbers, nor the truth that every change and relation in it can be expressed by analytic functions. At the same time a broad view of the theory admits the existence of a dependence only in the sense that we consider the numbers united with one another as if given together.

Now biology deals largely with aggregates of individuals, and then, like the pure theory of numbers, its variables are discrete, and must change by jumps of at least one individual.

A mathematics proper to such investigations has not been accessible to the biologist, for not only has his calculus been founded solely on continuity, but also his geometry has been developed for him on continuity assumptions from the very beginning.

The very first proposition of Euclid is to describe an equilateral triangle on a given sect (a given finite straight line). It begins: 'Let AB be the given sect. From the center A with radius AB describe the circle BCD. From center B with radius BA, describe the circle ACE. From the point C, at which the circles cut one another, etc.' But the whole demonstration is the assumption of this point C. Why must the circles intersect? Not one word is given in proof of this, which is the whole problem.

You may say the circle is a continuous aggregate of points. If so, then the circle can not represent a biologic aggregate of individuals.

Geometry can be treated without any continuity assumption, without continuous circles, in fact without compasses.

Such a geometry, a geometry for biologists, is my own 'Rational Geometry,' the very first text-book of geometry in the world without any continuity assumption.

How biology has been misled in its mathematics you will realize when you recall that geometry and calculus have been the basis of mechanics, mechanics the basis for astronomy and physics, physics the basis for physical chemistry, while even the theory of probability had no discontinuous mathematics specially its own.

Therefore, biologists had clapped over their eyes spectacles of green continuity, and these spectacles colored biologic theories with the following characteristics as enumerated by the Russian Bugaiev: (1) the continuity of phenomena; (2) the permanence and unchangeableness of their laws; (3) the possibility of characterizing a phenomenon by its elementary manifestations; (4) the possibility of unifying elementary phenomena into one whole; (5) the possibility of sketching precisely and definitely a phenomenon for a past or future moment of time.

These ideas make the very essence, the framework, the skeleton of modern biologic theories. They have forced their way in and imbedded themselves as being necessary to make possible the application of the methods of continuity-mathematics to the investigation of nature. They follow out the fundamental characteristics of continuous analytic functions. Therefore, we may designate our modern biology as a continuity-biology.

Thus, as the Russian Alexeieff has pointed out, after the continuity world-scheme had captured the fundamental natural sciences, geometry, mechanics, astronomy,

physics, chemistry, had intrenched itself in them and dowered them with generality, uniformity, universality, it went over gradually with scientific investigators by habit so to say into flesh and blood, and began to penetrate and dominate in physiology, in psychology, in sociology, in biology.

Darwin's attempt to found the law of the evolutionary origin of species is an outcome of the continuity world-scheme, permeated, saturated with its basal idea, continuity.

Just so strengthens itself more and more the persuasion of the continuous growth and continuous perfection of all the elements of human society in its natural advance.

The evolutionary development of social life permeates always more and more the view of the historian. Many writers are so habituated to this continuity world-scheme, that, without sufficiently critical consideration, they apply it where it is essentially inapplicable and inappropriate.

So we have the doctrine of a fatalist causality, denial of efficient freedom of the will, belittling of the idealistic endeavor of mankind, hence the pessimistic attitude toward the whole of human existence.

Paraphrasing a Russian poet:

Nature thus speaks to man:
"Thou mayst be head of creation,
But who gives thee any crown?
Dost thou believe, poor fool, in blind delusion,
That I am slave to thee, and thou my lord and master?
Of the thick veil lift I a corner tip
And Pygmy, then presumst thou
All through me that thou seest?
Seeing thine own small law and plan, art then deluded
Into the holy of holies to have pushed?
Oh fool! I do but nod and wretchedly thou'llt shudder,
Cower like timid dog on the sod. The earth
I shake and suddenly is dust
Thy pride and might, the greatest of thy cities.
War I send and pestilence its sister,
The blooming fields transform I into deserts,
The sea I drink up and the sun shroud I in darkness,
And thou, brute-like, wilt howl with pain, with anguish.
What you strive for and hope, to me that is indifferent.
Pity know I none, and my law of the number
Knows neither weal nor woe, knows neither praise nor blaming.
To unknown lands I stride in war, in whirlwind.
I know no aim, no end and no beginning.
I beget and I destroy, not prating, never angry,
The elephant and the worm, the wise man and the foolish.
So live as all live. Float out on the flood eternal
One instant brief, and vanish then forever.
Presume not stupid-bold with me to wage a contest,
With me eternal mother of all living and all dead."
So thunders nature with a million voices
In hail, in surge, in storm-wind and the lightning.

So much for the continuity world-scheme in biology.

But the latest advances in mathematics have rendered unnecessary for biology the wearing of this misfit garment.

The new mathematics gives now a standpoint for the explanation and treatment of natural phenomena from which the individuality of the biologic elements need not be suppressed.

It has triumphed for its own domain in cases where the continuity methods were wholly inapplicable, where arithmology, discrete mathematics, was called for and victorious.

Such are the problems which relate to the properties of whole numbers, solved so brilliantly in number-theory.

Such again are the questions relating to the enumeration of the geometric forms with n parameters which satisfy n given conditions. These even in the simplest cases showed themselves insoluble until finally between 1860 and 1870 the French mathematicians created special discrete

methods. Thence sprang a wholly new branch of mathematics, enumerative geometry.

A third, an epoch-making universe of discrete mathematics, is the wonderful invariant theory of the great Sylvester and his brother-in-arms Cayley, two men whose loss left the English-speaking world without a single mathematician of first rank, of the rank of Hilbert and Poincaré.

In chemistry this discrete mathematics has shown itself of such use and power that we may assuredly say chemistry owes its present standpoint almost wholly to two lines of advance, both discrete, the atomic structure theory of Kekulé and Mendelieev's periodic system of the chemical elements.

The brilliant and rapid advances in chemistry have come not from suppressing but from stressing the individuality of the elements. Its mathematics has been essentially discrete.

The arithmologic scheme of chemical research, the atomic structure theory of Kekulé, coincides completely with the scheme of the symbolic invariant theory, though both were worked out independently.

Now to biology and sociology, having to do with single individuals differing from one another, in biology cells, in sociology human personalities, the continuity mathematics with its universalism is so ill adapted by its nature that the discrete way of thinking must here soon take the chief rôle, giving as it does large and free play to the individual peculiarities of the elements to be studied.

The continuity thought-way strives to reduce all phenomena of nature to a general mechanism with fate-determined movement. Just contrary to this then is the view that living nature is a rationally-correlated realm, in which everything is harmonic, shows adaptation, strives toward perfection.

Are not the mechanical form-phenomena of the living organism only its most elementary properties, upon which are built others higher, psychic? Now the psychic properties of a living organism can not be studied by observation and comparison of the accompanying mechanical properties unless they flow from these mechanical properties. If these accompaniments be unessential, the psychic properties can not be concluded from them. Here is even yet the battleground.

Biologists are at present emphasizing the statistical method, but upon this modern mathematics has for them another message. They rely upon the method of least squares and mean value. But Chebyshev has demonstrated that not the great number, but the independence of the metric phenomena plays the chief part in the application of the theory of mean value. This independence is the essential requisite, and it is the very thing whose unwarranted assumption vitiates much biologic research.

An illustration may be drawn from fire insurance. From the records of past conflagrations of single houses, if the burning of each one is independent of that of every other, the theory of mean value can get a number which can be counted upon to recur with slight variation from year to year, and upon it can be based the charges for insurance.

To realize how completely this essential requirement may be lacking, we have only to remember the Chicago fire, or the Baltimore fire.

Biologists have treated their combinations as if they were simple summations of independent elements.

More likely are the combinations composed of interdependent factors whose symbolization must be at the simplest a product.

A tremendous illustration of variation under change of stimuli is given by Japan.

For centuries environment and potential variability were in static balance; variation was zero.

Then came Commodore Perry, humiliations to the inordinate pride of a hermit nation, defeats, contempt, a tremendous response to the changes in stimuli, and to-day dark pagan Japan is easily defeating the largest European Christian white nation: variability unchanged, variation the greatest recorded in human history.

According to Quetelet's celebrated law of variability published some years after Darwin's 'Origin of Species,' it is subject to the law of probability, and according to this law the occurrence of variations, their frequency and their degree of variation can be calculated and predicted in the same way as the chance of death, of murders, of fires.

But such applications did not fit actual evolution, since the law is to deal with different degrees of the same qualities, giving a continuity production of species, while as de Vries has so stressed, the origin may be by abrupt jumps, by sports, by mutations.

De Vries has said that a thorough study of Quetelet's law would no doubt at once have revealed the weak point in Darwin's conception of the process of evolution. It would have shown that the phenomena which are ruled by this law and which are bound to such narrow limits, can not be a basis for the explanation of the origin of species.

It rules the degrees and amounts of qualities, but not the qualities themselves.

Species, however, as de Vries says, are not in the main distinguished from their allies by quantities, nor by degrees; the very qualities differ.

How such differences of qualitative character have been created is the burning question. They have not been explained by continuous accretion of individual variations.

The attitude of the new mathematics strongly favors attempts like the mutation theory, based on the abrupt, explosive changes, wholly discrete, which under the name of 'sports' had long been observed and known in horticulture and animal breeding, and of which De Vries has found a whole fusilade being shot off by 'Lamarck's evening primrose.'

Here he says there is no gradual, no continuous change or modification, nor even a common change of all the individuals. On the contrary, he says, the main group remains wholly unaffected by the production of new species. After eighteen years it is absolutely the same as at the beginning. It is not changed in the slightest degree. Yet it produces in the same locality, and at the same time, from the same group of plants, a number of new species diverging in different ways.

The vastly vaunted natural selection, then, can only destroy new species, never create them.

GEORGE BRUCE HALSTED.
KENYON COLLEGE,
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THE ADMISSION OF STUDENTS TO COLLEGE BY CERTIFICATE.[1]

WHICH is better: the western plan of admitting students to colleges and universities by certificates from duly inspected secondary schools, or the eastern method of admitting only by examinations conducted by representative boards or otherwise?

The question assigned me as a topic is a pressing one at this moment in the history of American education. Within a few years it may be determined which plan,

[1] Paper read before the Department of Higher Education of the N. E. A., Asbury Park, N. J., Friday morning, July 7, 1905.

with all it implies in shaping far-reaching educational ideals and practises, shall be national. The terms 'western' and 'eastern' must not import provincial pride, or sound a note of sectionalism.

As a New Englander somewhat late adopted by the west, may it not be the good fortune of the speaker to lead you all in the discussion to common American ground?

We can adopt the words of Miss Lucy Larcom:

> Two worlds I live in—East and West,
> I can not tell which world is best;
> The friends that people both are dear:
> The same glad sun
> Shines into each; far blends with near,
> And then is now—and there is here—
> And both are one.

In truth there is no single 'western' or 'eastern' plan of admitting students to college, though there are dominating practises warranting the use of the terms. Bluntly stated, all the colleges are so anxious to get students that no system is consistently lived up to. They mix the certificate and examination plans, they distribute examinations in time and space, they annex local preparatory schools or have quasi-certified schools of individual tutors and coaches.

From the point of view of the entering student and of the average American, who believes in the widest opportunity for a higher education in a democracy, the existence of twelve gates open day and night in the college Jerusalem may seem desirable. But to the economist and educator the evils of the competition are glaring and threatening, and opposed to this age of the conquests of cooperation and combination.

A glance at the evolution of our methods of admission of students to college will show what evils are imminent, and which is the better plan of admission.

The so-called 'eastern' method of admitting by the examination of the individual student in its earlier form might have been called colonial or English. Originally, each college examined for itself. There was 'personal contact' between the student and examiner. The examination was more or less oral. The appearance and character of the candidate were weighed. With the increase of students and of entrance standards, the substitution of written examinations, first at the college, then at a distance and with the multiplication of studies, the applicants have become not even names, but mere numbers, to be hit at long range by rapid-firing examination-paper guns.

When the colleges began to fire into one another in concentrating their guns upon certain large preparatory schools, and particularly when the big universities brought up their heavy artillery loaded some with ancient and some with modern subjects and methods, the situation became well-nigh intolerable. The secondary school men cried out, and justly 'continually do cry,' and certain great movements were organized. Among the first was the New England Association of Colleges and Preparatory Schools dating from 1885. According to Dr. William C. Collar, of Roxbury, Mass., the association was formed for the purpose of bringing about uniformity in the requirements for college. He believed at the sixteenth annual meeting, in 1901, its work would receive its consummation by providing for admission examinations by a joint examining board as in the middle states and Maryland.[2] He believed these two boards 'would slay the certificate system and longed to see that done.'[3] It was believed that 'the certificate system was making no headway and that the colleges, generally speaking, would be glad to give it up.' On the contrary, apparently

[2] *School Review*, IX., 619, December, 1901.
[3] Page 625.

aroused by the discussion of this very meeting, the friends of the certificate plan formed the next year the New England College Entrance Certificate Board,[4] now consisting of eleven New England colleges.

Mr. Virgil Prettyman, principal of the Horace Mann High School, is an example of the schoolman's cry for relief. In an article on 'College Entrance Requirements and the High School Program of Studies'[5] he contrasts with to-day a generation ago, when a boy was admitted to college with a training which would to-day place him not higher than the junior year of high school. The colleges require a training two years in advance of former times.[6] The increase is in quantity rather than quality. One must know more things. It is a question if he needs to know any one thing better. "The Harvard examinations are arranged in such a way that a boy must keep fresh in at least six studies up to the close of junior year of the preparatory course. Unless a boy passes in at least three subjects (eight credits) no credit whatever is given. It is necessary for the pupils in the last two years of the preparatory course to carry at least six studies abreast. The total result of the present program of studies is haste in preparation, dissipation of energy and interest, physical strain or a tendency to negligence of duties and illiteracy." Mr. Prettyman suggests two remedies (not including the certificate system, in my opinion the cure for his difficulties): "Reduce the number of studies and raise the passing mark or permit the boy to take examinations in three years instead of two, as at present. The necessity for haste and for a cramming process is the greatest burden of the secondary schoolman. Will the colleges lend a helping hand to the school?"

[4] First Annual Report, 1902–1903, Providence, Snow & Farnham, 1904.

[5] *Educ. Rev.*, 28: 304–305, October, 1904.

[6] Cf. Professor John H. Wright, of Harvard, *School Review*, V., 700.

Another representative secondary school man, Mr. Edward J. Goodwin, of Morris High School of New York City, in an article on 'A Comparison of College Entrance Examinations,"[7] shows the blight for secondary schools of separate examinations by the individual universities, and indicates what a great want brought forth when it established the college entrance examination board. His study is a comparison of the questions of this board with those of Harvard, Yale, Princeton and Pennsylvania. He rejoices "in the attempt to evolve a scientific method of examination that shall test the instruction and training of candidates for admission to college with substantial accuracy, without cramping the schools, or blighting the enthusiasm of the teachers. That the college entrance examination board has made invaluable contributions toward the accomplishment of this end can not be doubted."

The rise and progress of the college entrance examination board represents doubtless the best that can be done for 'the eastern method of admitting only by examinations,' and meets, where it is accepted, the evils of the conflicting examinations of competing colleges complained of by the secondary school men. Organized[8] as recently as November 17, 1900, at Columbia, under the inspiration of Nicholas M. Butler, its first secretary, it has grown from eleven colleges and four representatives of the secondary schools in the Association of Colleges and Preparatory Schools in the Middle States and Maryland, to twenty-five colleges and universities and seven representatives of the secondary schools.

It has fulfilled the hope expressed by the editor of the *Educational Review* in 1901, that it would hold annual uniform exam-

[7] *Educ. Rev.*, 26: 440–456, December, 1903.

[8] *Educ. Rev.*, 22: 264, October, 1901.

inations in June, for the entire territory north and east of the Ohio and Potomac.[9] The candidates examined have risen from 973 in 1901 to about 2,100 in 1905. Examinations have just been held at about 160 points in the United States and its dependencies and five points in Europe. A staff of almost 100 readers at the offices in New York City are to pass on more than 20,000 examination papers.[10]

In the words of President Butler: "The board has accepted the opportunity that President Eliot pointed out during the discussion which led to its formation of 'making an immense contribution to American education.'"[11]

In this day of 'cooperative endeavor' it has been whispered, is it possible that the eminent forerunners of the college examination board, the regents of the University of New York, with their tested examination system and its thousands of candidates might join in the combination? Further, there have been movements to make the tests for graduation from secondary schools identical with the tests for admission to college, upon the basis of the college board's examination papers. Mr. Fiske, the present secretary, says 'it is to be devoutly wished.'[12] He declares that the work of the board is now almost ready to pass from a temporary initial state to a permanent condition.[13]

Impressed by its record and that the time of its crystallization is at hand, one can not suppress the query—will the college entrance examination board become national? Will it fasten an examination system upon us? Of course, to do this it would have to change its local complexion from a little group of twenty-five institutions centering about Columbia. The tendency to a close corporation, since membership is no longer dependent upon meeting an announced standard, but upon election, would have to be reversed.

After the fashion of the Equitable Life, the nature as well as the vastness of the interests would require the mutualization of stock subject to some form of governmental inspection. To cover the national field the present work of the board would have to be so hugely increased that its present work would appear Lilliputian. Taking the figures of the United States census of 1901–2,[14] and the present modes of the board with the desire accomplished that graduation from the school should be dependent upon passing the board's papers, instead of examinations at 160 points they would be at the 8,127 public and private high schools. The present average of 9½ papers for each graduate would require for the 66,262 graduates, the reading of 629,489 papers in place of the present 20,000 and a staff of above 3,000 readers in place of 100, at an expense upon the present estimate of $5 a candidate or $331,310, in place of the present $10,000.

Though the scheme smacks strongly of concentration and the dangers of bureaucracy and lacks a point of national attachment in the bureau of education as at present organized, there is nothing insuperable in it, if the college entrance examination board system is really better than any other.

Before making answer we must review two or three competing plans. First is that of old-fashioned examinations held by individual colleges. In his annual report last week to the Yale Alumni, President Hadley surprised some by saying 'we shall

[9] *Educ. Rev.*, 22: 531, December, 1901.

[10] Article by Thos. S. Fiske, secretary, in *N. Y. Daily Evening Post*, June 20, 1905.

[11] *Educ. Rev.*, 22: 296, October, 1901.

[12] *Educ. Rev.*, 24: 305, October, 1902.

[13] *Ibid.*, 302, October, 1904.

[14] Annual Rep., 1902, Dept. Interior Com., of Ed., Vol. I., xvii.

probably continue to hold separate examinations instead of joining with other colleges.'[15] We may take him as the fairest and ablest protagonist of the old way, while recognizing possibilities of new ways, as is shown by his address on 'The Use and Control of Examinations' before the department of superintendence of the National Educational Association in February, 1901.[16] In brief he says: An examination has two distinct aspects, one looking toward the past, the other toward the future. It is a means of proving a student's past attainment and also of testing his power for that which is to come. A written examination is apt to be a test of the *range* of a student's proficiency rather than of his thoroughness. It loses a major part of its value as a measure of fitness for anything which is to come.

In the passage from the high school to college, the evil is felt most seriously because of the complete separation of control and the remoteness of location, which so often make a system of personal consultation impossible. Here is the most acute controversy. Three methods have been devised to make the range of examination questions wider, to supplement the written examinations by other tests like certified note books, to depend upon certificates given by the teachers of the candidates.

The first method may give too much help to the undeserving student. It offers great opportunities for the coach, for hasty cramming and for the evils of the English civil service and university examinations. The second method of supplementing and correcting the results of examinations by accepting certified note-books, etc., has the merits and defects of a compromise. The frank adoption of a certificate system as a whole would be more logical and better.

[15] *N. Y. Daily Times*, June 28, 1905.

[16] *Educ. Rev.*, 21: 286–300, March, 1901.

The third method, a certificate system, without full discussion of its merits and demerits, has much in its favor. A good preparatory teacher in nine cases out of ten can judge of the fitness of his pupils to enter college better than any college entrance examination board. Each teacher also has a freedom in choice of methods which is of great advantage to him and his pupils.

The first obvious objection is that not on account of dishonesty, but of incompetency, a large number of our secondary school teachers can not be trusted to give certificates. Second, the abandonment of an examination by the college takes away an important stimulus for keeping up the standard of admission requirements. The third objection and the decisive argument for the retention of the old plan is that the colleges which insist on examinations think they get a better class of students by that means than by any other. They get the boys who do not shirk a trial. The fable of the choice of the two doors applies. The first door is labeled 'who chooses me shall get what he deserves,' the second, 'who chooses me must hazard all he has.' The certificate system attracts those who would go to the former door, the examination system those willing to venture the latter.

If each of these alternatives thus proves unsatisfactory, is there not some possible combination which may be suggested? Let us divide our requirements into three groups of subjects:

First, the prerequisites for power to go on with collegiate study, viz., mathematics and the required languages, to prove power of precise thought and of precise expression, where the examinations would be maintained in the hands of the college which is to have the student in charge.

The second group of subjects, viz., the

prescribed readings in English literature, in Latin and modern languages, is considered auxiliary to the attainment of power signified by the first group. President Hadley says: "I should be in favor at once of putting all examinations on the extent of knowledge in these auxiliary subjects into the hands of a common examination board. Whether it would be wise to go a step further and introduce the certificate system in subjects of this group, is a matter which I should hardly like to prejudge at present."

In the third group of studies, history and descriptive sciences, which President Hadley assumes are not a necessary basis for subsequent work, but part of a general scheme of secondary education, recognized by the colleges as a concession to satisfy teachers able to teach them and not to degrade these subjects, the certificate system would be allowed from the very outset.

In wrestling with the objections to his combination and complex, if not compromise, system, he finds relief in extending 'to teachers of proved ability the opportunity to recommend at the risk of their own reputation for provisional admission to our freshman classes pupils to whom the new system seemed to have done injustice.' Thus President Hadley is not far from the kingdom of the outright accrediting system for which we hope he may become a leader, not only amongst his brethren of the eleven colleges in the New England College Entrance Certificate Board, but throughout the nation. The whole thing might be done if Commissioner Draper and President Butler became his coadjutors.

There is time for but a moment's glance at the evolution of 'the western plan of admitting students to colleges and universities by certificates from duly inspected secondary schools.'

It might be called the continental or German plan, whence it in part came to reinforce preeminently and first in Michigan, a state system of public schools crowned by a state university. It, in some form, logically accompanied a state public school system with a teaching state university, and has been cheerfully adopted, and to their edification, by the private colleges and universities, so that it covers the entire territory from the Ohio to the Pacific and overflows into southern and eastern states.

In its rudimentary form, which the New England College Entrance Certificate Board has adopted, an applying school is placed on an approved list when it can prepare for a college course, and continue to prove its ability to give preparation for college by the record of its students already admitted to college. The admission of the candidate without a collegiate examination in the subjects for which he is certified as prepared by the approved school is probationary.

Naturally, with the increase of schools and students and with a zeal to maintain standards, there followed the visitation of the approved schools by members of the faculty related to preparatory subjects. Thus informally inspection of schools began, until now there are twelve state or state university inspectors in as many great western states, supplemented by visitors from the faculties including great private institutions.

In the North Central Association of Secondary Schools and Colleges, there has been for six years a commission on secondary schools and college entrance requirements, at the heart of which is a board of high school inspectors. Uniform standards and entrance blanks have been prepared. For some time by comity schools accredited by one state university have been accredited by another. But now a list of first-class schools meeting the standards of the commission is becoming an accredited list throughout the entire northwest. In an-

other way has been attained what President Butler said the college entrance examination board stood for: "Uniformity of definition, topic by topic, with a uniform test, uniformly administered. Each college will continue to fix its own standards of admission and to admit its own students."[17]

The difference is that the examination or uniform test is of the institution and not of the individual, ridding us of the evils of personal and paper examinations, massed so that all is staked at once for the pupil. President Hadley's allusion to the fable of the two doors is too literally true. Entrance examinations become a gamble and the student seeking to gamble is commended.

A long line of witnesses might be cited from inspectors, college and secondary schoolmen working under the plan of certificates from duly inspected schools, all in favor of the plan:

A few citations pertinent to our discussion will help to answer the question before us.

Leon J. Richardson,[18] of the University of California, shows how the accrediting system has evolved rapidly since 1883 in that state, in harmony with republican institutions. The schools voluntarily established their relations with the university and may sever it at will.

Wm. J. S. Bryan, principal of the normal and high school of St. Louis, says the practise of admitting to the university on certificate only the pupils who have graduated from the approved schools has been a powerful lever in raising the standard of the work done.[19]

Edwin G. Dexter,[20] professor of education, University of Illinois, says: "The east has been attempting the system of admission to college through the certificate system —a modified accrediting system—but they have left out of it the high school visitor, and therein lies the trouble. No inspection on the part of a college professor can ever take the place of the visitation of the inspector, the expert of the secondary school system, the trained friend, adviser and helper and visible connecting link with the university." An advantage of the accrediting system is the increased proportion of high school students who go to college. It is suggestive that in the graduating class of the public high schools in the North Atlantic States, the part of our country little given to the accrediting plan, twenty-six per cent. were for the year 1901 in the college preparatory course. In the same class in the North Central States, where accrediting prevails, the percentage was thirty-four. The accrediting system gives the college students with a better average preparation. The University of Pennsylvania receives about an equal number each year upon each of the two plans—individual examination and certificate. In the fall of 1901, 112 entered by the first method, and 101 by the second. At the end of the semester 49 per cent. of those entering by examination were conditioned as against only 29 per cent. of the certificated students. A suggestive but not a conclusive comparison is of the percentage of failure in first year subjects in one of the Atlantic coast universities, admitting only by examination, and those of five of the larger middle west state universities, where eighty per cent. enter without examination. East, failed algebra, 26 per cent.; trigonometry, 34 per cent. West, failed algebra, 15 per cent.; trigonometry, 11 per cent.

Principal Ramsey, of Fall River, some

[17] *Educ. Rev.*, 22: 291, October, 1901.

[18] *School Review*, 10: 615–619, October, 1902.

[19] Proc. 5th Annual Meeting N. C. A. S. S. and C., 11, 1900.

[20] Nat. Conference Secondary Ed., N. W. University, p. 94, October, 1903.

years ago in a study to determine the relative merits of the two methods of college entrance, received answers from college officers in favor of certificated students: In mental ability, five to one; in the general performance of college duties, three to one.

Professor Whitney, of Michigan, investigating the freshman grades of more than 1,000 students, about equally divided between those entering upon credit and those taking entrance examination, found that the average standing of the former was more than one and one half per cent. higher than for the latter.

Impartial testimony might be gleaned from European educators. Professor T. Gregory Foster in the report of the last Alfred Mosely Commission[21] rejoices that it is a fundamental principle in American universities, that the man who is fit to teach is also to be trusted to examine his own students. He remarks: 'As long as examinations control the teaching, whether in universities or schools in this country [Great Britain], so long will the teaching continue to be academic in the worst sense of the word, cribbed, cabined and confined.' He notes the degree to which examinations by external bodies or examiners is regarded as baneful in the United States both to the pupil and for the educational organization, and commends the attempt of the college entrance examination board to guard against some of the evils by having secondary schoolmen on the board. But to Professor Foster the accrediting system of the middle west is 'a more significant plan' and one rapidly spreading into the east. He says: "In the states where it has been adopted, the whole educational system has been unified and strengthened. The barriers between various grades of teachers are being removed. The teaching of all classes of teachers is thereby made more direct, more stimulating and attractive to students. The accrediting system as *versus* the older leaves the teacher and the taught free and thereby stimulates to better training." Professor Foster quotes President Harper as opposed to the accrediting system when he left Yale, but now as a firm believer in it as a result of his experience. The professor concludes: 'It is perhaps one of the most noteworthy contributions of America to educational progress.'

[21] Pp. 115–118.

Mr. M. E. Sadler,[22] director of special inquiries and reports, Educational Department of England and Wales, speaks decisively as to certain principles applicable to our discussion:

"State certificates bestowed as results of written examinations at a prescribed moment at the close of their school life, are injurious in their influence as well on the work of the schools as on the physical, mental and ethical development of the pupils and also on the national ideals of education, and on the parents' conception of what education can do and ought to do. The more valuable influences of a secondary school lie in its tone, its ἦθος, in its tradition, in the outlook which it encourages its pupils to take on life and duty, in the relation between teachers and scholars, in the relation among the scholars themselves. None of these things can be tested by written examinations, conducted by examiners, however able or impartial, who have never seen the school. It is judged on *paper*. It is possible for a school to simulate great intellectual efficiency by reason of an intensive process of 'cram' which reflects immense credit on the skill and industry of the teachers, but guarantees little of permanent educational value to the pupils prepared. Yet a system of merely written

[22] *Educ. Rev.*, 21: 497–515, May, 1901; cf. pp. 507–12.

examinations conducted by examiners at a distance fails and must necessarily fail to discriminate between two effects superficially and temporarily similar, but really and permanently different.''

He adds: 'The natural antithesis to written examinations is a system of inspection.' He weighs the difficulties of inspection in a national provision for secondary education, and would find a formula for some form of consultative committee with the state—'neither to have too much state nor too little state.' ''*Laissez-faire* is impossible in this period of rapid transition.''

This last is true in America. What we do we must do quickly. A national system, meaning thereby governmental coordination and possible inspection in harmony with the voluntary cooperation of private institutions, like the accrediting systems now prevailing in many western states, concatenating secondary schools, colleges and universities, will give modern interstate educational privileges, long needed to keep up with interstate commerce and life and heightening national ideals and power.

The line of evolution is clear. The oral examination of the individual pupil by the separate college, the written examination in the same fashion, the combination of colleges for written examinations, the slight recognition of the preparatory teacher in the combination, the great recognition of the preparatory teacher and his examinations by the certificate plan, and the highest point of evolution, the examination by the combined colleges of the secondary school as a whole, and the accrediting of it organically, trusting it all in all or not at all.

The disappointed hearer who looked for a formal disputation in this paper may be still demanding a categorical answer to the question of our topic 'Which is better, etc.?'

Let him draw his own conclusions from the testimony marshalled from the best representatives of the different systems.

As an evolutionist I see every system has a part to perform, and perceive certain principles at work which promise us not only a better system, but a national and best.

George E. MacLean.
University of Iowa.

SCIENTIFIC BOOKS.

Text-book of General Physics for High Schools and Colleges. By Joseph S. Ames, Ph.D., professor of physics and director of the physical laboratory in the Johns Hopkins University. New York, American Book Company. 1904. Pp. 768.

About eight years ago Professor Ames published his 'Theory of Physics' and established his reputation as a skillful writer of text-books. The present volume was initially undertaken as a revision of the former one, but the author soon found that it was more convenient to prepare a new book independently, with occasional inclusion of matter that had been previously put into such good form as to require but little modification. He believes now, as then, that to present the subject of physics to a class of students three things are necessary: a good text-book; experimental demonstrations and lectures, accompanied by recitations; and a series of laboratory exercises. This book is intended to state 'the theory of the subject in a clear and logical manner so that recitations can be held on it.'

The class-room presentation of any subject that requires frequent experimental illustration necessitates the abandonment of the text-book by the teacher while engaged in the work of exposition. The text-book becomes the basis for parallel study on the part of the auditor, and recitation days are most conveniently differentiated from exposition days. Presumably the present volume is the writing out of at least the greater part of the lectures given at Johns Hopkins University to the students of general physics, who are assumed not to possess at the outset any knowledge of advanced mathematics. It was probably for

this reason that on the title page the book is said to be 'for high schools and colleges.' The clause 'for high schools' is probably superfluous. If there are any high schools in which a book of this grade can be successfully employed they are quite exceptional.

Assuming that the book is exclusively for collegiate students, or others of equivalent maturity, it is very interesting and suggestive, well up to date, and abundantly worthy of cordial commendation. The first 212 pages are taken up with the mechanics of solids and fluids, each chapter being closed with a well-selected list of books of reference. About 100 pages are then devoted to the phenomena and laws of heat, including a brief chapter on thermodynamics. Vibrations and waves receive quite full treatment, 80 pages being devoted to this subject before that of sound is mentioned. The analysis of sound, musical instruments and musical compositions make up three short chapters, about 27 pages in all. To the subject of light 175 pages are given; and to magnetism and electricity, 167 pages. This may seem like a significant reaction against the popular demand for utilitarianism in physics, but it is not altogether surprising that emphasis should be laid upon the phenomena of heat and light in a laboratory where Rowland's influence in behalf of pure science was so long dominant. The theory of electricity is brought out with much clearness and in excellent style, while less than five pages are devoted to dynamos and the engineering applications of electricity to industry.

A distinct defect in this otherwise excellent book is the complete absence of illustrative problems. The author may, perhaps, prefer to avoid these as class-room tests, or he may use them spontaneously and prefer not printing problems, the solutions of which can be transmitted down from class to class. The majority of teachers are probably agreed that the use of problems is indispensable in the conveying of accurate ideas when the subject is such as necessarily to imply the application of mathematics, whether elementary or advanced.

Possibly a separate small volume of problems, as a supplement to the text-book, may be forthcoming in the near future. If so it will be welcomed by those who use this book either for reference or in the hands of their students. But, even as it stands, it is worthy of the welcome which it can not fail to receive.

W. Le Conte Stevens.

A Catalogue of North American Diptera. By J. M. Aldrich. Smithsonian Miscellaneous Collections, Vol. XLVI., No. 1444. 1905. Pp. 1–680.

The long-expected catalogue of North American diptera by Professor Aldrich has at last appeared. It is the first work of its scope to be published since Baron Osten Sacken's catalogue which was issued by the Smithsonian in 1878. During the intervening quarter of a century the aspect of entomology in North America has greatly changed, more especially in the diptera, rendering the new catalogue most welcome.

The following remarks from Professor Aldrich's introduction show the relation which exists between the two works:

> The great amount of work which has been done on North American Diptera within the quarter of a century has largely changed the face of the subject. Hence the reader will probably observe, especially at first, more of contrast than resemblance. The number of species has doubled; the number of references to previously known species has almost doubled; several families have been monographed or revised, with more or less change of nomenclature; along with this has gone the publication of a multitude of smaller papers, touching every family but one, and the larger part of the genera. Under these conditions it is inevitable that great changes should appear in the new catalogue.

The catalogue is rather unique among the present lists of American insects in several respects, all of them commendable. The faunal limits are not restricted to the countries north of the Mexican boundary, but are extended to include as far as Panama and the West Indies on the south. This gives a much more lasting value to the enumeration of species than is possible when the banks of the

Rio Grande and the gulf coast are regarded as the edge of a zoological chasm, which dare not be crossed except by the numerous Mexican and West Indian species which are discovered every year in Texas and Florida.

The references to strictly anatomical and biological papers are also most useful, representing a phase of the subject which is usually entirely crowded out in an essentially taxonomic catalogue. If future cataloguers of other groups would profit by this example they could greatly enhance the value of their work without an expenditure of much extra space and labor.

The special references under many of the families and separate genera to special papers relating to such groups will prove a great assistance to the inexperienced worker as well as a convenience to others more versed in the scattered literature of the subject.

The bibliography fills some 68 pages, including all papers of any importance published before January 1, 1904, while an appendix covers the literature of 1904.

As must be the case with any catalogue covering so large a group, a great number of generic and specific names have been reduced to synonymy since the last authoritative list. These have been dealt with in an admirable spirit of conservatism which contrasts sharply with the extravagant overturning of names often indulged in by insect cataloguers. To quote the writer's own words: 'I have been influenced by the feeling that my catalogue must represent the actual condition of classification, not merely my own views.'

It is to be hoped that the catalogue will stimulate the increasing interest in this group. It will certainly be a great aid towards accurate dipterological work in this country.

CHARLES T. BRUES.
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SCIENTIFIC JOURNALS AND ARTICLES.

THE June number (volume 11, number 9) of the *Bulletin of the American Mathematical Society* contains: Report of the April meeting of the Society, by F. N. Cole; Report of the April meeting of the Chicago Section, by J. W. Young; 'A general theorem on algebraic numbers,' by L. E. Dickson; 'On the deformation of surfaces of translation,' by L. P. Eisenhart; 'The groups of order 2^m which contain an invariant cyclic subgroup of order 2^{m-2},' by G. A. Miller; 'Galileo and the modern concept of infinity,' by Edward Kasner; 'Notes' and 'New Publications.'

The July number contains: 'A survey of the development of geometric methods,' by M. Gaston Darboux, translated by H. D. Thompson; 'Note on Fermat's numbers,' by J. C. Morehead; 'Simply transitive primitive groups which are simple groups,' by H. L. Rietz; 'Remarks concerning the variation of the length of a curve,' by T. J. Bromwich; Review of Joly's Manual of Quaternions, by J. B. Shaw; Shorter notices of Zeuthen's Geschichte der Mathematik in XVI. und XVII. Jahrhundert, by D. E. Smith, and of Tannery's Introduction à la théorie des fonctions d'une variable, by L. E. Dickson; 'Notes' and 'New Publications'; 'Fourteenth annual list of papers read before the society and subsequently published'; Index of volume 11.

THE July number (volume 6, number 3) of the *Transactions of the American Mathematical Society* contains the following articles:

H. POINCARÉ: 'Sur les lignes géodésiques des surfaces convexes.'

T. J. I'A. BROMWICH: 'The classification of quadrics.'

J. E. WRIGHT: 'On differential invariants.'

L. I. NEIKIRK: 'Groups of order p^m, which contain cyclic subgroups of order p^{m-3}.'

G. A. MILLER: 'On the invariant subgroups of prime index.'

E. W. BROWN: 'On a general method for treating motions and its application to indirect perturbations.'

L. E. DICKSON: 'On hypercomplex number systems.'

J. H. MACLAGAN-WEDDERBURN: 'A theorem on finite algebras.'

J. ROYCE: 'The relation of the principles of logic to the foundations of geometry.'

J. PIERPONT: 'On multiple integrals.'

The American Naturalist for July contains an article on the 'Restoration of the Titano-

there Megacerops,' by R. S. Lull, accompanied by an illustration which differs from others previously made in showing the animal with a short, double nasal horn. This, it is argued, was, like that of the rhinoceros, composed of agglutinated hairs. We have another of the 'Synopses of North American Invertebrates,' this, No. XXI., by W. R. Coe, being devoted to the Nemerteans, part I. W. B. Davis gives the sixth paper on 'Studies of the Plant Cell,' and the balance of the number is devoted to reviews and correspondence.

The American Museum Journal for July is termed the Reptile Number, the major part of its contents consisting of a synopsis of 'The Reptiles of the Vicinity of New York City,' by Raymond L. Ditmars, accompanied by a key and numerous excellent illustrations. The article is issued separately as Guide Leaflet No. 19.

The Zoological Society Bulletin for July is as good as its predecessors. C. William Beebe describes 'The New Bird House' at length, giving a number of fine illustrations of the building and its contents. There is an excellent article on 'Labeling Live Animals' with samples of the labels used at the New York Zoological Park, one on 'Tree Planting at the Zoological Park' and another on 'Our Series of Batrachians.' The illustrations are particularly good.

The Museums Journal of Great Britain for July completes the fourth volume of this valuable publication and includes the index. Its leading articles are 'The New Local Museum in Bad Bielohrad, near Jitschin, Bohemia,' by Anton Fritsch, and 'A System for the Registration of the Contents of Museums,' by L. Wray, of the Perak Museum. The interest and value of the *Journal,* however, lie largely in its numerous brief notes relating to many museums.

DISCUSSION AND CORRESPONDENCE.

THE NEEDS OF SCIENTIFIC MEN.

Much has been said recently about the desirability of offering 'brilliant prizes' to men who 'succeed' in science. In Science of July 7, p. 27, are some fresh remarks on this subject, from the address of President Roosevelt to the alumni of Harvard. The time has come when the worm, with the kind permission of the editor, desires to turn.

I write as an ordinary working naturalist, and on behalf of my kind. We neither expect scintillating 'success,' nor do we look forward to any prizes in the way of highly-paid positions. Our needs are mainly two: (1) adequate time for work and (2) a living wage. These are exactly the things we can not have, in the present state of this country. It is only necessary to make a few inquiries among scientific workers, to find out that very few, even among the most distinguished, can pursue their studies unhindered. A very short time ago I had a conversation with one of the most able naturalists America has ever produced, holding an apparently excellent position, and he explained to me how he was obliged to spend a large part of his time in routine work, because of the lack of adequate assistance. A day or two later I talked to a man who has a most intimate knowledge of a certain group of animals, and has discovered many new facts; but few of his discoveries will ever be put in print, because of the incessant pressure of other duties. These men are not part of the 'great unemployed'; they hold positions most people would envy; and, moreover, they are excellent samples of all the rest.

The difficulty is intimately connected with the other one, that of the living wage. There is no living wage for *research;* research in pure science is at present a parasitic industry, to borrow a term from the economists. Both of the men I have just referred to get their salaries for doing economic work, and whatever they do in pure science is supported and made possible by the other. A still larger body of researchers lives upon the proceeds of teaching, while those who *actually get a living by research* are very, very few. The experiment stations, even, do not disobey the general rule, for the demand for immediate results of economic value is such that the workers are almost obliged, in the majority of cases, to desist from work of a broad and fundamental

character; while most of them, of course, have to do a large amount of teaching.

It would be difficult or impossible to overestimate the value of the teaching and economic work referred to. They are indispensable and in every way worthy of the support they receive. But research in pure science—meaning by this term research directed toward ascertaining the methods of nature without immediate economic or educational ends—is even more necessary, for it is the rock on which the other two must necessarily build. It also must be supported—and by whom? Surely by the recipient of the benefits it confers, that is, the human race.

I can not agree with President Roosevelt that the highest work will never be affected by the question of compensation. It will be and is continually affected by the fact that it can not get even the wherewithal to keep the machine at work. On the other hand, it is likely to be totally destroyed, if affected at all, by the offer of 'brilliant positions.' For what are these positions, judging from those now existing? Mainly and often wholly executive; useful and honorable, indeed, but not, in their essence, *scientific* positions at all! Who proposes to pay a man ten thousand a year, and then *leave him alone to go on with his work?* Really, the situation suggests a slang expression, not fitted for the pages of SCIENCE.

I once heard of an Englishman who said he would work hard in science until he got his F.R.S., and would then stop. We do not want men with that spirit, who begin and continue with the hope and expectation of a prize, financial or social. The scientific man has his real prizes, which he values highly and of which he can not be robbed; these are to see his ideas and discoveries woven into the fabric of human knowledge, and become integral and essential parts of the great temple of which he is one of the myriad builders. This alone is to him worth while; and it is a positive injury to divert him with baubles. His prayer is, to be permitted to work as long as life lasts, and that it may be said of him, as I heard it said of that fine old entomologist, J. O. Westwood, in his last years, 'he never gets tired.'

T. D. A. COCKERELL.

THE EDITORSHIP OF THE ENGINEERING AND MINING JOURNAL.

TO THE EDITOR OF SCIENCE: On July 1, 1905, Mr. T. A. Rickard relinquished the managing editorship of the *Engineering and Mining Journal,* a position which he held with merit for two and a half years. Although Mr. Rickard has been succeeded by others who will maintain the high standing of the *Journal* as a technical magazine, his voluntary retirement, in my opinion as an American geologist, is a distinct loss to science in this country, inasmuch as, in addition to his intimate knowledge of the business side of mining, he appreciated the important relation of this subject to geology. Through this appreciation, during his editorial encumbency, he secured and stimulated many excellent original contributions upon the geology of interesting localities, which would not otherwise have been published.

Of all the economic applications of geology, the questions pertaining to the origin, occurrence and availability of ore deposits are by far the most important, and, perhaps, the sympathy and encouragement of mining men have been the greatest impetus in this country toward securing the means of purely scientific research.

The numbers of the *Journal* edited by Mr. Rickard constitute a most valuable addition to the annals of American geology, and it is hoped that the talents of business integrity, high idealism and charming literary style, so rarely found in combination with scientific knowledge and so well developed in him, will not long continue idle.

That Mr. Rickard has recently declined a professorship of mining in the Royal School of Mines, a position which carries with it title and honor, and has chosen to remain in America, will be gratifying to all of his confrères in the geological profession.

R. T. H.

SPECIAL ARTICLES.

A FOOTNOTE TO THE ANCESTRAL HISTORY OF THE VERTEBRATE BRAIN.

THE existence of a pair of newly recognized ganglionated nerves, attached to the fore-brain of that ancient group of fishes—the Selachians—is, perhaps, of sufficient general interest to justify a brief mention in SCIENCE.

In recent numbers of the *Anatomischer Anzeiger* (Vol. XXVI., Nos. 2/3 and 4/5) the writer has described and illustrated the morphology of such nerves in twenty genera, and twenty-seven species, of selachians, and their embryonic history in one. Similar nerves have also been pointed out by Allis, Pinkus and Sewertzoff in two of the Dipnoi (*Protopterus* and *Ceratodus*), and one ganoid (*Amia*). So far as observations go these nerves are absent in all other vertebrates. The facts now made known, although in one sense merely anatomical details, may, nevertheless, be looked on as constituting a footnote to the great chapter in morphological science dealing with the structure and development of the vertebrate brain.

The fore-brain is extremely modified in structure, and so little understood that it is desirable to gain any new facts bearing on its organization. So far, comparative anatomy and embryology combined have supplied only fragmentary views as to its nature, the number of segments that may enter into it (or, indeed, whether it is segmented at all), and as to its line of development. Although the solution of these matters is likely to take many more generations, yet, in the meantime, details of structure hitherto unknown may help, be it ever so little, in the anatomical analysis of that region of the brain.

The new nerves referred to above exist in adult stages of selachians. They are, on the one hand, connected with the fore-brain and, on the other, with the olfactory epithelium. They arise earlier in embryonic history than the olfactory nerves, appearing on the anterior summit of the fore-brain near the neuropore. Peripherally they intermingle with the olfactory fibers, but, at all stages of their existence, they are entirely independent of those fibers, and they never come into relation with glomeruli as the olfactory fibers always do.

As to their surface connections with the brain wall, they exhibit two types: those having a dorsal or semidorsal attachment to the brain-wall, and those having a ventral attachment. It is, however, to be borne in mind that the superficial attachment of a nerve is of small significance in determining its position, as in the case of the fourth nerve, which

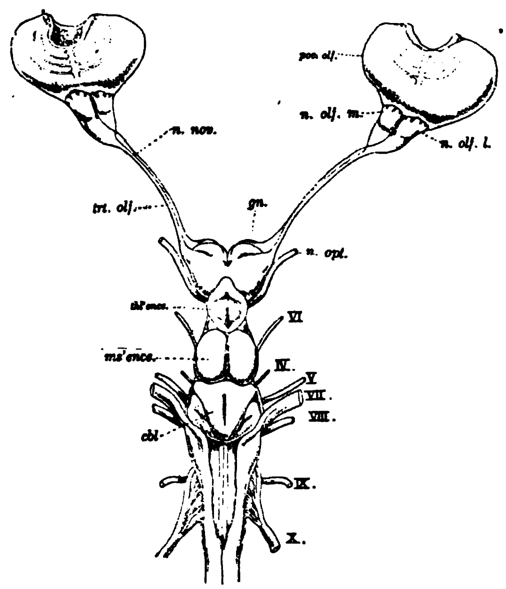

FIG. 1. Brain of *Squatina angelus*, from above, natural size.

emerges from the dorsal surface of the mid-brain, while its neuroblasts lie in the ventral zone.

As an illustration of the first type, reference may be made to Figs. 1 and 2 showing, respectively, the brain of the angel-fish (*Squatina angelus*) and that of the spiny dog-fish (*Squalus acanthias*), one of our commonest selachians.

In Fig. 1 the new nerve (*n. nov.*) is seen attached by two roots to the dorsal surface of the prosencephalon, and, bearing just in front of the brain, a filiform ganglion (*gn.*). From this point it runs like a delicate thread along the olfactory tract, and dips into a fissure separating the two great divisions of

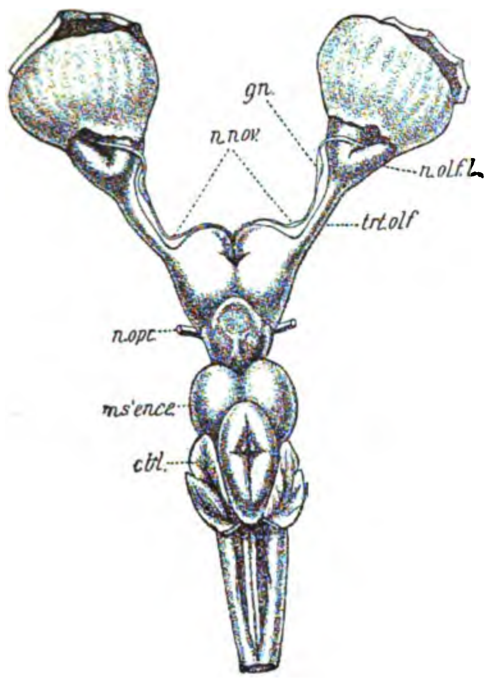

FIG. 2. Brain of adult *Squalus acanthias*, from above, natural size.

the olfactory nerve. Thereafter it branches and passes to portions of the nasal epithelium.

In *Squalus acanthias*, Fig. 2, the central ends of the nerve are located within the median furrow of the fore-brain, and its ganglion (*gn.*) is near the base of the olfactory bulb.

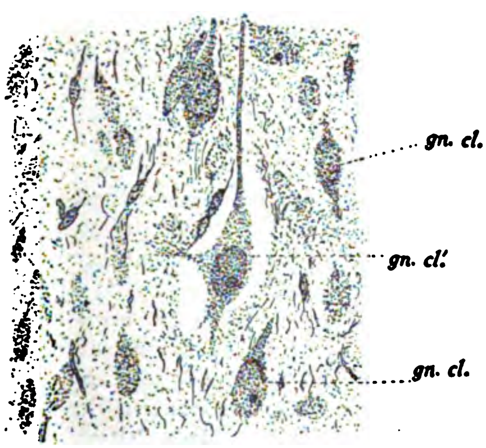

FIG. 3. Section of the ganglion of the new nerve of *Squalus acanthias*, × oc. 2, obj. 2/3 in.

The microscopic structure of the ganglion, shown in Fig. 3, resembles that of a spinal ganglion. It is surrounded by a covering of connective tissue from which supporting strands pass into the interior of the ganglion. The ganglion-cells are arranged in clusters and layers between the nerve fibers and connective tissue elements. The nerve-cells are for the most part bipolar (*gn. cl.*), but a limited number of other ganglion cells (*gn. cl.'*), with angular outlines and several processes leading from them, may also be seen, which suggest the presence of multipolar cells.

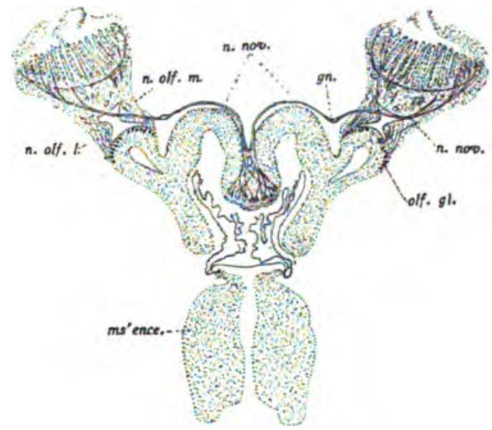

FIG. 4. Partly diagrammatic figure of a horizontal section of the brain of *Squalus acanthias* six inches long. Showing portion of the central and peripheral endings of the new nerve.

The central terminations and peripheral distribution of the new nerve are shown in Fig. 4. This is partly diagrammatic, being based on a section in the horizontal plane of the brain of a *Squalus acanthias* about six inches long. Centrally, the nerve fibers enter the brain substance, and after much branching are distributed mainly within an eminence upon a median infolding of the pallium. This eminence is supposed to correspond to that designated '*eminentia septalis*' by von Kupffer in the amphibian brain.

The study of serial sections shows that the fibers of the chief branches of the nerve are distributed, peripherally, to the olfactory membrane, in the antero-lateral portion of the olfactory cup. There are also some smaller

branches passing to the median portion of the cup. While the terminal twigs mingle intimately with the olfactory fibers, they retain

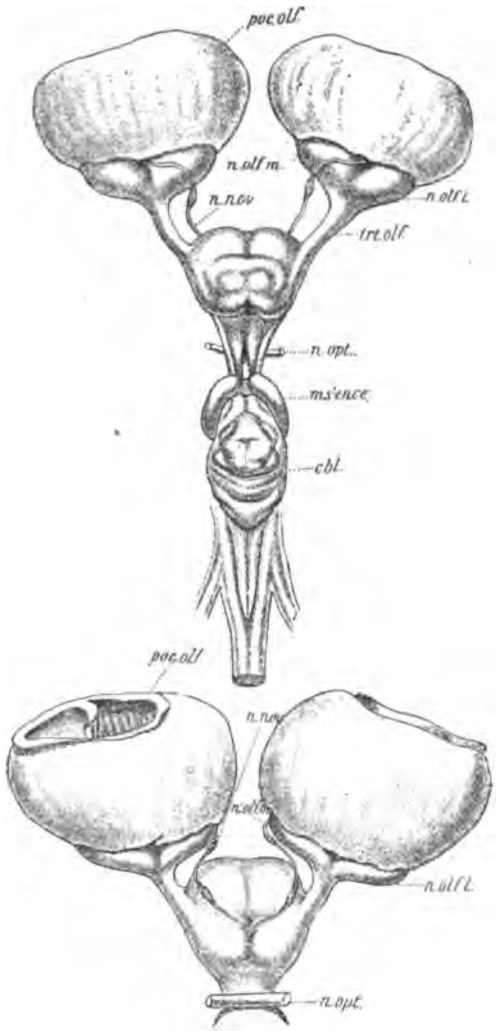

FIG. 5. Brain of adult *Mustelus canis*, from above, and portion of the same from below, both natural size.

their independence and do not anastomose with them.

The dorsal attachment of the nerve to the brain has been determined in eleven genera, and sets aside the idea that it is usually, or normally, connected with the ventral surface, as has been suggested on account of its ventral position in *Amia*, *Ceratodus* and *Protopterus*.

As an illustration of the other type, having a ventral attachment with the brain, we may take the brain of the common smooth hound (*Mustelus canis*) of the Atlantic coast, which is shown in Fig. 5. Here, the nerve emerges from (or enters) the brain substance on the ventral surface, about midway between the anterior border of the prosencephalon and the optic chiasma. It is interesting to note that, in embryonic development, it first arises upon the dorsal part of the primary fore-brain and is carried to its ventral position through the unequal growth of the brain-wall. The nerve penetrates the brain substance, and, after branching, terminates in the same region as in the brain of *Squalus acanthias*.

As shown in the figure, the nerve has two ganglia—a distal and a proximal one—as is the case with the ninth nerve. The peripheral distribution of the fibers is similar to that in *Squalus acanthias*.

A few comments in reference to this nerve may not be out of place. The only similar nerve known outside the group of selachians is in *Amia, Protopterus* and *Ceratodus*. In the two former genera no ganglion was observed by either Allis or Pinkus, but Sewertzoff, in 1902, noted a ganglion on this nerve in embryonic stages of *Ceratodus*. The ventral position of the nerve, close to the *recessus præopticus* in the three forms mentioned, led Sewertzoff to propose for it the name of '*Nervus præopticus*,' but its dorsal position in so many selachians would make that name inappropriate. Earlier (1899) I had suggested in a tentative way the name '*accessory olfactory*,' which is also objectional, as it prejudices the question of its function. Since this nerve arises on the morphological tip of the primary fore-brain, and during some stage of its existence is closely connected with the *lamina terminalis*, I think the designation '*Nervus terminalis*' will fit all cases and will be a suitable name for it.

Both its anatomy and embryology, as given in my paper in the *Anatomischer Anzeiger*, bring out its marked individuality and separateness from other cranial nerves. This would justify calling it a 'new nerve' and, therefore, giving it a new name.

In the selachians, its close association with the main olfactory and its distribution within the olfactory cup, might give ground for the suggestion that it is a radix mesialis of the olfactory nerve. This, however, appears to me not well founded, since the nerve has no connection, at any time of its growth, with olfactory glomeruli. Even if it be one of the olfactory bundles in an unusual position, its method of origin, and difference from all other olfactory radices would still justify the use of the designation 'new nerve.'

It is a relatively simple ganglionated nerve that has apparently undergone little modification. This, in itself, is a very notable circumstance, on account of its position on the brain in a region of extreme modification. Since it has remained in a relatively archaic condition, we may conclude that its function has not been greatly elaborated. It may have been largely supplanted by the development of the olfactory, or some of the branches of the trigeminus.

When all circumstances of its structure and development are taken into account, it seems to me not unlikely that we have here the remnant of a very ancient nerve, whose original function is unknown, which in the process of development has been reduced to secondary rank, through the prodigious development of adjacent nerves and brain territories.

It has been shown that this nerve precedes the olfactory in embryonic origin, but the assumption would not be justified on this account, that it is, therefore, older in phylogenetic history, though such may be the case.

Its development in so many adult selachians would indicate that it is still functional, though reduced to a subsidiary rank.

Its ganglion will throw it among sensory nerves.

But, while it has a sensory moiety, some considerations indicate that possibly it has also a motor moiety. It has two roots, and in the skate, both medullated and non-medullated fibers have been observed in it.

It will be extremely difficult to determine its physiological properties by experimentation. Its minuteness will render any manipulation or experimental study difficult without giving injury to the olfactory.

It is doubtful if any trace of it be preserved in higher vertebrates. Whatever its original function may have been, it was in some way superseded in the evolution of animal life, and having first lost its importance, it thereafter disappeared. I have looked with especial care for it in a number of amphibians and teleosts, and in the chick. Both embryonic and adult stages have been examined in *Necturus, Amblystoma,* the frog, the toad, the trout, the catfish and the chick, but in none of them has the nerve been found.

From any point of view, it is extremely interesting that we have preserved so fully in selachians and Dipnoi a ganglionated nerve in front of the optic, bearing in its anatomy testimony as to its ancient features, but of which all traces have disappeared in higher animals.

NOTE.—Since the above was sent to the printer the 'Nervus terminalis' has been observed in two rare selachians of ancient type —*Chlamydoselachus* and *Mitsukurina.* Professor Burt G. Wilder noted its occurrence in the former, photographed it, and, subsequently, sent me a portion of the brain embracing the nerve. In *Chlamydoselachus* it is similar in position and anatomical features to the nerve in *Hexanchus.* It is connected with the fore-brain, within the median furrow, and upon the terma about midway between the dorsal and ventral surfaces. It runs directly to the olfactory cup. Near the base of the cup it has an enlargement which, upon microscopic examination, proved to contain ganglion-cells. As in *Hexanchus,* the main branch of the nerve joins the median instead of the lateral division of the olfactory fibers.

Professor Wilder also generously sent for my examination the anterior portion of the brain of *Mitsukurina.* In that rare and costly form the nerve is connected with the ventral surface of the brain by two roots. It has a very distinct ganglion lying on the olfactory crus near the base of the bulbus.

WILLIAM A. LOCY.

THE IMPORTANCE OF INVESTIGATIONS OF SEEDLING STAGES.[1]

The selection of the title, 'The Importance of Investigations of Seedling Stages,' for presentation before the Section of Vegetable Morphology of the International Congress carries with it the suggestion that it is the intention of the writer to epitomize the recent attempts made to solve the problem of the phylogeny of Monocotyledons by reference to the anatomy of seedlings. The importance of these investigations is beyond question and the unexploited nature of the field has never been better expressed than by Miss Sargent, whose name occupies the most important place in these discussions, when she remarked that while theoretically the embryo should offer characteristics of unusual taxonomic importance, the only character so far of recognized value seems to be that employed in the separation of the two great divisions of the Angiosperms.

But this work has already been brought to the attention of botanists by foreign and American writers and I speak of it only incidentally in passing to the consideration of some other, though related, points, omitting, of necessity, many interesting and suggestive illustrations which would require far too much space for their adequate discussion.

The recent revival and defense of the conception of the cotyledon as homologous with the nursing foot of the lower forms rather than with foliar organs has suggested many problems which will require a broad comparative study of all embryonic stages for solution.

The functions performed by the cotyledons are various, the protection of younger embryonic regions, the deeper planting of the young seedling, and above all, elaboration, storage and absorption of food material, or in other cases the cotyledons are merely vestigial structures. If it be maintained that the cotyledon is homologous with a more primitive nursing foot and that the Dicotyledons are derived from the Monocotyledons by a bifurcation of an originally simple member, the whole series of adaptive modifications of the cotyledon must be studied and arranged in series in agreement with their origin.

This presents problems of no mean magnitude, physiological and morphological, the solution of which demands the accumulation of a vast series of comparative data. Not only do the differing degrees of physiological specialization and morphological modification of the cotyledon among Monocotyledons offer problems of interest and importance, but the evolution of epigean and hypogean cotyledons in the dicotyledons must be more satisfactorily traced. If the close resemblance of many cotyledons to foliar organs is merely similar structural adaptation to the same physiological function, the problem is not *solved*, but the point of view is simply changed, since the origin of such adaptations offers a group of knotty problems which will require painstaking research for their solution. If the cotyledons of many Onagraceæ are the homologues of haustorial organs, what is the nature and action of the 'correlation' which demands that the portion of the cotyledonary lamina interpolated after exposure to the light shall have a structure and venation in close agreement with that of the true leaves which follow rather than with the simple form and tissue of many other cotyledons which are photosynthetically active for a long time.

If, on the other hand, the old and generally accepted view is considered the correct one and cotyledons are regarded as foliar in nature, the series of forms is almost as puzzling and as much in need of broad and comparative investigation and arrangement.

The morphology of the cotyledon has been called into question through a consideration of the relationship of Monocotyledons and Dicotyledons. Apparent transitions from one great group to the other have been discovered. These apparent transition stages have been used to support two antagonistic views of the relationship of the two great groups. It is apparent that the special data so far secured are very meager and, if it exists, the connection between the two great groups must be

[1] Read before the International Congress of Arts and Science, St. Louis Exposition.

established by the discovery of a more complete series of transition stages. If, on the other hand, the forms to which so much significance has been attached are merely adaptations to peculiar life conditions, assumed by a plant at an exceedingly plastic stage of its development, the problem of the relationship of the two great groups seems to be farther than ever from a satisfactory solution.

The value of seedling characters for the tracing of phylogenetic development in families and lower systematic groups and an understanding of past changes both in the race and in its environmental conditions, has been emphasized by several writers. The most satisfactory results in this field are those obtained by Ganong and Cockyane, who have both worked principally with xerophytic forms which offer especially promising material for such researches, though here extreme caution must be exercised in deciding whether distinctive characters of the adult are not merely an expression of the direct influence of the environment upon a plastic organism, while the juvenile stages, owing to the different conditions of growth, are not subjected to these influences, and consequently all the potentialities of their primordia may be realized instead of intercepted and diverted or modified by powerful environmental influences. It scarcely need be suggested that here experimental morphology and ecology have before them material for a series of very interesting monographs.

A field in which results of especial interest may be expected is the comparative investigation of the later developmental stages within the same systematic group. For families Ganong has presented a masterly treatment of the Cactaceæ and Willis has accumulated some data for, and suggested the importance of, such work in the Podostemaceæ, while Miss Sargent's work on the Liliaceæ, when it appears, will doubtless represent the most extensive study of the kind ever undertaken. In other families there is a large store of details waiting for supplementary researches and correlation. The results so far obtained show beyond question the interest, ecological, morphological and phylogenetic, attached to the study of these groups. While I would not discourage the investigations of these larger groups, it must be admitted that in the present state of our knowledge there are many uncertainties connected with the generalizations concerning their phylogeny, and for the present especial importance should be attached to the investigation of the minor groups, particularly the genera. We have little right to assume the monophyletic origin of the most of the families, while with the genus this is more justifiable, though even here the greatest caution must be used. The embryonic stages, especially the later ones, should be of the greatest value in just this connection, for theoretically they ought to furnish us with an indication of form prevailing prior to the assumption of the more specialized adaptive characters.

But before we may draw conclusions as to the phylogeny of a group or conclude whether monophyletic or polyphyletic in its origin, from characters offered by the later embryonic stages of its members, we must first understand thoroughly the seedling and its reaction to all the factors influencing it. This is a field not for comparative work alone, but for physiological, ecological and experimental morphological investigations as well. Comparative studies are of the highest importance, but in this case they must be carried out upon material of systematically homogeneous nature. Until the appearance of Professor de Vries's epoch-making work no one has had available for study a series of forms unquestionably descended from the same ancestor. It is highly desirable that some one take up such types as the new elementary species of Professor de Vries for the purpose of ascertaining in how far there is a relation of ancestral characters and to what extent there is in the seedling a working back into the embryo of the characters of the adult. While the new species of *Œnothera* described by Professor de Vries are the simplest systematic units, there are some very suggestive points to be found in his descriptions. The relative stages of development at which the differential

characteristics of the new species make their appearance seem not without significance. In some there is an immediate and complete obliteration of the *Lamarckiana* characters, while in others, as in the 'atavism' of *O. nanella,* the new characters replace those of the old only at a later period of development. Such cases as that of *Trifolium,* in which there was a working back into the embryo of the divided condition of the leaf as the number of leaflets characteristic of the mature plants increased offer suggestion for an important phase of statistical investigation. Investigations of the seedlings of some of the teratological 'varieties' may be expected to yield results of great interest, especially when taken up from the experimental and historical point of view.

The chief object of the study of seedling stages, phylogeny, is dependent for its realization upon the validity of the recapitulation theory. In many cases this seems to hold, but, as pointed out above, a broad, comparative investigation of minor groups is imperative. Results of importance are assured. Developmental stages in the same group will generally show either a close similarity or present a series of perplexing differences. The conclusion in the one case will be that community of descent or identical environmental conditions are responsible. In the other case —and of this a considerable number of striking illustrations might be cited—polyphyletic origin of groups hitherto supposed to be monophyletic must be assumed, or the differences must be accounted for on the ground of adaptation or mutation and the importance of ontogeny as a key to phylogeny greatly restricted. With reference to seedling stages the statement that ontogeny recapitulates phylogeny must be made with great reserve. Doubtless it has here an evolutionary significance, but its application is a matter of serious import. It seems to me that in vast numbers of cases, the sweeping back of later developed characters in the nature of adaptations to environment or otherwise has obliterated ancestral features, especially the superficial ones, to such an extent that an attempt to reconstruct the phylogenetic tree is quite out of the question.

In the examination of seedling stages, experimental morphology may find, as we have already suggested above, a fertile field for research in the determination of the degree of plasticity of juvenile and adult types. Some structures seem to be merely the result of the direct environmental influence, but others can not be modified by the changing of conditions. Some characters seem to be well fixed, while others are apparently merely the product of immediate influences of the environment. While phylogeny is the chief end, experimental morphology may find in seedling stages material of value for use in the formulation and solution of some of its fundamental problems.

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Missouri Botanical Garden and
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CURRENT NOTES ON METEOROLOGY.

CYCLONIC AND ANTICYCLONIC TEMPERATURES.

A very useful summary of 'Various Researches on the Temperature in Cyclones and Anticyclones in Temperate Latitudes' has been prepared by H. Helm Clayton, of Blue Hill Observatory, and is published in *Beiträge zur Physik der freien Atmosphäre,* Vol. I., No. 3, 1905. It is probably known to men of science generally that one of the most interesting of present-day problems in meteorology concerns the origin of the cyclones and anticyclones which are such characteristic phenomena of the prevailing westerly wind belts, and constantly impress themselves upon us by reason of their control of our weather changes. Mr. Clayton presents an outline of the work of Hann, Dechevrens, Berson, Teisserenc de Bort, Rotch and others, including his own important results; points out the contradiction which exists between the conclusions of those who believe that cyclones are colder than anticyclones and those who find them to be warmer, and gives it as his opinion that both sets of investigators may be partly right. The author calls attention to the fact that those who have found the cyclone colder have considered the temperature in relation

to pressure without regard to time, while those who find the cyclone the warmer have, with one exception, considered the temperature with relation to the time of maxima and minima of pressure. A treatment of the data used by Teisserenc de Bort according to the method adopted by Clayton, leads the latter to results exactly the opposite of those obtained by the former.

In order to explain the results found at Blue Hill, Clayton has adopted the hypothesis that there are two causes for areas of low pressure: (1) an area of cold which contracts the air and tends to cause cyclonic circulations in the upper air, and (2) an area of warmth which expands the air and tends to cause cyclonic circulations in the lower air. These two cyclones are not necessarily connected. Both affect surface pressures, and both probably usually exist simultaneously within a few hundred kilometers of each other, and may form part of one system. The warm-air cyclone of the surface has hitherto received the most attention. In this somewhat complex relation of upper and lower cyclones, as hypothecated by Clayton, we may find a satisfactory adjustment of conflicting views.

METEOROLOGY AT COLORADO COLLEGE, COLORADO SPRINGS.

METEOROLOGY is developing under favorable auspices at Colorado College, under the direction of Professor F. H. Loud. The observatory building, erected in 1894, was the gift of Henry R. Wolcott, Esq., of Denver. There is a full equipment of meteorological instruments, some of which are exposed on the flat roof of the observatory, while others are placed on the roof of a neighboring building, east of the observatory and on higher ground. Tri-daily eye observations are made, and from the self-recording instruments the conditions at the end of each hour during the twenty-four are determined. Monthly and annual summaries for 1904 are contained in the *Semi-Annual Bulletin of the Colorado College Observatory* (*Colo. Coll. Studies;* Gen. Ser., No. 16; Science Ser., Nos. 39–41; Vol. XI., pp. 119–190; April, 1905). In addition, Professor Loud discusses the topography of the district, the diurnal changes of atmospheric conditions (illustrated by curves) and the cold wind of October 24, which came at the time of the usual morning increase of temperature and gave a daily maximum at 4 A.M. This wind, which was observed by two parties at high altitudes, began with a shallow flow of cold air from the north, in front of an approaching anticyclone. The cold stratum seems to have run beneath the quiet air of the region, lifting it and giving rise to a thin stratum of cloud which resulted from condensation by reason of ascent. Sometimes these conditions give rise to a slight fall of snow. A paper on 'The Evolution of the Snow Crystal,' by John C. Shedd, embodies some results of studies made during the winter of 1901–02 at Colorado Springs. The author believes that the primitive crystal is, for the tabular form, of the 'fern stellar' type, *i. e.*, open in structure and with many branches, while for the columnar form it is the hollow column; that the solid tabular, solid columnar or granular forms are the final forms to which all others tend, and that there are two general processes of transformation from primitive to final forms. One process is that of accretion, and the other is that of transformation, in which the losses and gains result in a change in form, but not necessarily in amount of material.

NEOLITHIC DEW-PONDS.

A RECENT study of 'Neolithic Dew-ponds and Cattle-ways,' by A. J. and G. Hubbard (London, Longmans, Green and Co., 1905), brings out some interesting evidence of the construction of dew-ponds by the early inhabitants of Great Britain. The process of construction was as follows: An exposed position where springs were absent was selected, and the hollowed surface was covered over with straw or some other non-conducting material. Over this was spread a thick layer of clay, strewn with stones. Condensation during the night from the lower air on the cold surface of the clay provided the water-supply for the pond. Springs and drainage from higher ground were avoided, because running water would cut down into the clay surface

and wet the straw. Some of these ponds, of very early date, perhaps Neolithic, are still in working order.

PILOT CHARTS OF NORTH ATLANTIC AND NORTH PACIFIC OCEANS.

THERE is much of interest to teachers of physiography and of meteorology on the monthly pilot charts of the Atlantic and Pacific Oceans issued by our Hydrographic Office. So far from containing only information for the use of mariners, there is a large amount of material which may easily be employed in school and college teaching. For example, the conditions of prevailing winds and calms; the limits of the trades; the interaction of general and local winds near the coasts of continents and islands; the distribution of fogs and many other subjects of direct meteorological interest are discussed, as well as charted, on these publications.

SUICIDE AND THE WEATHER.

M. DENIS has recently published a study entitled 'Le Suicide et la Corrélation des Phenomènes moraux en Belgique' (*Mem. Acad. roy. Belg.*), in which the relation of suicide and the weather is considered. At Brussels the number of suicides increases up to July and August, and the minimum is usually in December (*Ciel et Terre*, Vol. 26, 1905, No. 6). R. DEC. WARD.

RECENT VERTEBRATE PALEONTOLOGY.

PARTIES are now in the field from the Carnegie Museum, the Field Columbian Museum and the American Museum of Natural History. From the last institution three parties have been sent out, one to continue the work of excavation in the 'Bone Cabin' Quarry in search especially for additional skulls of dinosaurs; the second to the Bridger Eocene basin, in order to verify the stratigraphic exploration which has been done there and to complete our knowledge of certain little known forms; the third to the Laramie or Upper Cretaceous of northern Montana in search of dinosaurs. In the absence of Professor Bashford Dean in Japan, his assistant, Mr. Hussakof, is exploring several of the type localities of Devonian fishes.

Much activity is also being displayed in the arrangement of the collections in the various museums. Mr. J. W. Gidley, who resigned his position in the American Museum for an appointment as preparator in the National Museum, is completely overhauling and cataloguing the rich National Museum collection. In the Carnegie Museum the specimens are temporarily withdrawn from exhibition pending the completion of the new building. In the American Museum of Natural History the skeleton of the little Bridger armadillo *Metacheiromys* has just been placed on exhibition, while the skeletons of the Pampean horse *Hippidium*, of the Jurassic carnivorous dinosaur *Allosaurus* and of the Pleistocene mammoth *Elephas columbi*, are being prepared for mounting. Mr. Richardson, who prepared such an admirable model of *Stegosaurus* for the National Museum exhibit at the St. Louis exposition, is now preparing for a life-size reproduction of *Allosaurus* after a model by Knight from the skeleton in the American Museum of Natural History.

The principal researches in this museum at the present time are the following: Dr. O. P. Hay is monographing the Testudinata on a grant from the Carnegie Institution. Dr. E. C. Case is writing a memoir upon the Permian Pelycosauria, especially the great fin-backed lizards *Naosaurus* and *Dimetrodon*, fine specimens of which are preserved in the Cope collection in this museum; the drawings for this memoir are being made from a grant from the Carnegie Institution. Dr. W. D. Matthew has been revising the Bridger fauna, especially the Carnivora and Insectivora. Mr. Barnum Brown has completed a description of an important Pleistocene cave fauna of Arkansas. Volume II. of 'The Fossil Vertebrates in the American Museum of Natural History' has recently been issued, including forty-four collected bulletins, from 1898 to 1903, by Osborn, Wortman, Matthew, Hay, Granger, Gidley, Loomis, Brown, Lull, Gregory.

The status of the U. S. Geological Survey monographs at present is as follows: The monograph on the Ceratopsia by the late Mr. J. B. Hatcher will be published first. The

author at the time his fatal illness overtook him was in the midst of the final pages of the systematic revision of genera and species; he left his manuscript, so far as prepared, in perfect condition. Professor R. S. Lull, of the Massachusetts Agricultural College, has completed the monograph, carefully conforming, so far as possible, to the plans of the author. It has been found necessary, however, to add considerable original matter. The Titanothere monograph is progressing rapidly in the hands of Professor Osborn; recent discoveries in Wyoming have added greatly both to the material and to the work involved in completing this volume. The Sauropoda monograph by the same author is also under way, but will not be completed for at least two years. It has been practically decided to confine the Stegosauria monograph, in the hands of Mr. F. A. Lucas, to the genus *Stegosaurus* and thus avoid the delay incidental to the study of the European members of this order.

H. F. O.

SCIENTIFIC NOTES AND NEWS.

THE fiftieth year of public service of the eminent chemist Dr. D. J. Mendeléef will be celebrated at St. Petersburg on August 30.

DR. SAMUEL G. DIXON, president of the Academy of Natural Science of Philadelphia, has been appointed commissioner of health for the state of Pennsylvania.

PROFESSOR W. W. MILLS has been appointed state geologist of Michigan.

DR. ROBERT KOCH, who is said to be making important discoveries in the interior of Africa, expects to return to Germany in the spring of next year.

PROFESSOR C. H. HITCHCOCK, of Dartmouth College, is this summer studying the volcanoes of the Hawaiian Islands.

PROFESSOR G. F. WRIGHT, of Oberlin College, is making a trip to southern Russia and the Red Sea to continue his geological and anthropological studies in that region.

DR. J. F. NEWSON, associate professor of mining and metallurgy at Stanford University, has leave of absence for next year.

PROFESSOR MORIZ BENEDIKT, of the University of Vienna, known for his work on diseases of the nervous system, has celebrated his seventieth birthday. A dinner was given in his honor by the Neurologic Society of Vienna and congratulations were presented from various societies of which he is a member.

THE gold medal of the British Medical Association has been presented to Sir Constantine Holman and to Mr. Andrew Clark.

THE French Académie de Médecine has awarded a silver medal to Dr. Alan Green, bacteriologist in charge of the vaccine lymph department, Lister Institute of Preventive Medicine, for his work on vaccine.

DR. GUSTAV KRAATZ, president of the German Entomological Society, has been given the title of professor.

DR. RICHARD ASSMANN, titular professor of meteorology at Berlin, has been appointed director of the aeronautical observatory at Lindenberg.

WE learn from the London *Times* that Mr. Edgar Schuster, the Francis Galton research fellow in national eugenics at London University, has presented a report containing a preliminary account of inquiries which have been made into the inheritance of disease, and especially of feeble-mindedness, deafmutism and phthisis. Arrangements have been concluded with Mr. John Murray for the publication of a work on noteworthy families in modern science, written by Galton in conjunction with Mr. Schuster. This is to appear as Volume I. of the publications of the Eugenics Record Office, and will contain accounts of the families of some fifty fellows of the Royal Society.

A STATUE of Benjamin Franklin is to be erected at Paris at the end of the street that bears his name. Plans have been made for the celebration of the two hundredth anniversary of Franklin's birth, which occurred on January 17, 1706, in Boston and New York as well as in Philadelphia.

Nature states that a portrait medallion, in marble, of Sir William Geddes, the late principal of the University of Aberdeen, has been

completed, and will be placed in the Geddes transept of the library at King's College. Its unveiling will probably take place at the beginning of the winter session. A meeting in furtherance of the proposed memorial to the late Professor James Nicol was held recently in Marischal College, when a number of letters from geologists and old pupils of Professor Nicol were read, the general tenor of which favored the placing of a portrait tablet in bronze in the geological museum. There will be, it is hoped, a formal inauguration of the memorial during the centenary celebrations of next year.

Mr. Guy M. Bradley has been killed while protecting the birds of the Florida coast in the service of the National Association of Audubon Societies.

Dr. J. L. Chaufleury van Ysselstein, formerly professor of medicine at Amsterdam, has died at the age of eighty-six years.

Dr. Eduard Tangl, professor of botany at the University of Czernowitz, has died at the age of fifty-seven years.

Dr. Paul Schultz, docent in physiology in Berlin, died on July 18, at the age of forty-one years.

We learn from *The American Geologist* that the late legislature of Illinois established a state geological survey, putting it under the immediate direction of the trustees of the state university at Urbana, but with an advisory board consisting of the governor, the president of the university and one other to be appointed by the governor. The annual appropriation is twenty-five thousand dollars. In addition to the above, the university is to have a school of ceramics supported by an appropriation of five thousand dollars per year. This, however, will have no connection with the survey except such as common interest dictates.

The international committee having in charge the International Catalogue of Scientific Literature met in London during the last week in July.

The British Medical Association opened its annual meeting at Leicester, on July 25, under the presidency of Dr. George Cooper Franklin. The association will meet next summer in Toronto.

The fourth meeting of the German and Vienna Anthropological Society will be held at Salzburg on the 28th to the 30th of the present month.

An announcement has been issued in regard to the International Congress on Tuberculosis, to be held at Paris from October 2 to 7. There will be four sections, medical pathology, surgical pathology, preservation and assistance of infants and the same for adults.

We learn from *The British Medical Journal* that the International Surgical Congress will meet at Brussels beginning September 18, under the presidency of Theodor Kocher, M.D., professor of surgery in the University of Berne. The morning of each day will be arranged for visits to hospitals and clinics, and for the presentation and examination of patients, and for other matters of interest connected with the congress as well as the city of Brussels. The afternoons will, as far as possible, be reserved for the consideration of the subjects selected for discussion. These are as follows: (1) The value of the examination of the blood in surgery; (2) the treatment of prostatic hypertrophy; (3) surgical intervention in non-cancerous diseases of the stomach; (4) treatment of articular tuberculosis; (5) the treatment of peritonitis; (6) the diagnosis of surgical diseases of the kidney. Other communications of a practical nature (of which due notice should be given, as well as the time they will occupy) including the presentation of patients, specimens, and surgical instruments and appliances may be made. The official languages of the congress are English, French, German and Italian.

The General Council of Chambers of Commerce of the Commonwealth of Australia, at a meeting held in Sydney, in June, the following resolution passed: "That this General Council of the Chambers of Commerce of the Commonwealth of Australia views with satisfaction the increasing public interest in the metric system of weights and measures, and

expresses the hope that it may very shortly be adopted for England and the empire generally, and recommends that such legislation may now be framed in the commonwealth as will enable us to at once follow the home country in this change."

IT is stated in *Nature* that the council of the Royal Meteorological Society, being desirous of advancing the general knowledge of meteorology and of promoting an intelligent public interest in the science, has appointed a lecturer who is prepared to deliver lectures to scientific societies, institutions and schools on payment of a moderate fee and the cost of traveling expenses, the subjects being—how to observe the weather; weather forecasting; climate; rainfall; thunderstorms; meteorology in relation to agriculture, health, etc. The society is also prepared to lend and fit up a complete climatological station for exhibition, showing the necessary intruments in position and ready for use, and to lend in return for a nominal amount sets of lantern slides illustrating meteorological phenomena.

ENGLISH journals state that the government of India has ordered the introduction of a standard time, with effect from July 1, on the railways (other than small local lines, where the change might be inconvenient) and in all telegraph offices in the country, and also in Burma. Hitherto Madras time has been adopted by most of the Indian railways. The standard now to be introduced is nine minutes in advance of the 'railway time,' as it is called in all parts of India, and is thus 5½ hours in advance of Greenwich, being the local time of longitude 82° 30′. The standard for Burma is to be exactly an hour earlier, viz., 6½ hours in advance of Greenwich and five minutes earlier than Rangoon local time. In inland places it has been found convenient generally to follow railway time; but the great seaports of Calcutta, Bombay and Karachi have followed the local time of their respective longitudes. The government of India does not prescribe the new standard for these and other places following local time, but if a general desire to adopt the new standard is evinced, the government will be prepared to support the change and to cooperate in bringing it about. In all probability, therefore, there will ere long be a uniform time throughout India exactly 5½ hours in advance of Greenwich, while that of Burma will be 6½ hours in advance.

Nature says: "The proposal made by the Emperor of Germany for the temporary interchange of professors with America for a course of lectures is leading to a number of important results. Harvard University has invited Professor Ostwald, of Leipzig, to give a half year's course and Columbia University has secured lectures from Professor V. F. Bjerknes, of Stockholm, on 'Fields of Force,' and from Professor H. A. Lorentz, of Leyden, on 'Extensions of Maxwell's Electromagnetic Theory.' Is Great Britain with its usual insularity going to keep aloof from the new movement? It is hardly likely that any proposal from our country would fail to obtain hearty support either in Germany or in America."

UNIVERSITY AND EDUCATIONAL NEWS.

A COMMITTEE of the alumni of the Massachusetts Institute of Technology, with Mr. F. L. Locke, '86, as chairman, has addressed a circular to the alumni asking their opinion of the advisability of opposing in the courts the recent vote of the corporation of the institute in favor of an alliance with Harvard University. It states that a league has been formed "to oppose the contemplated alliance with Harvard University or any similar alliance; to defend the educational freedom of the Massachusetts Institute of Technology, and to promote the influence of the faculty and past students in its government." In regard to the action of the corporation, it says: "Such extraordinary exercise of corporate power in marked disregard of the moral obligation to respect the opinions and desires of those directly interested in the welfare of the institute raises a question more important even than the abandonment of its independent educational policy."

MRS. E. A. JEFFERS, of Richmond, Ind., has bequeathed $60,000 to Ohio Wesleyan University and $35,000 to De Pauw University.

The American Geologist states that Mr. G. K. Gilbert has given to the department of geology of Denison University upwards of 1,000 volumes of literature, consisting of U. S. Geological Survey reports, state reports, reprints, proceedings and other valuable books. It will be remembered that the library of the university was destroyed by fire some time since.

The Vienna correspondent of the London *Times* writes that the prime minister has laid before the House of Parliament a bill empowering the government to devote 25,000,000 crowns for the purposes of higher education, chiefly for medical teaching. The sum will cover the cost of building a new institute for physico-medical investigations, a new institute for hygiene in Vienna, and a new central home for several medical institutions of minor importance. In Prague both the German and the Czech universities are to be reconstructed; in Lemberg a new clinic for medicine and for surgery is to be provided; and in Cracow new clinics are to be erected and a medical library is to be founded.

The amount allotted by Parliament to each of the University Colleges for the year 1905–6 will be as follows:

Manchester	£12,000
University College, London	10,000
Liverpool	10,000
Birmingham	9,000
Leeds	8,000
King's College, London	7,800
Newcastle-on-Tyne	6,000
Nottingham	5,800
Sheffield	4,600
Bedford College, London	4,000
Bristol	4,000
Reading	3,400
Southampton	3,400
Dundee	1,000
	£89,000

A chair of protozoology has been established in the University of London, the secretary of state for the colonies having arranged for an appropriation for this purpose of £700 a year for five years. The academic council has further appropriated a sum of £200 a year for assistants and laboratory expenses in connection with the chair.

Professor Maynard M. Metcalf, of the Woman's College of Baltimore, has been appointed professor of zoology at Oberlin College.

Dr. Austin Flint Rogers, of Columbia University, has been made assistant professor in the department of geology and mining at Stanford University.

Dr. Oliver M. W. Sprague, assistant professor of economics at Harvard University, has accepted a chair at the University of Tokio.

At the University of Colorado, Mr. J. H. Wallace, B.S. (Illinois), has been appointed instructor in graphics, and Mr. Saul Epsteen, A.B. (California), Ph.D. (Zurich), instructor in mathematics.

Dr. Wilfred H. Manwaring, S.B. (Michigan, '95), M.D. (Hopkins, '04), at present fellow of the Rockefeller Institute for Medical Research and assistant in pathology in the University of Chicago, has been appointed head of the new department of pathology and bacteriology in Indiana University, with the rank of associate professor.

Mr. Leroy D. Swingle, A.B. (Lafayette), science teacher in Seattle (Wash.) Seminary, has been appointed fellow in zoology at the University of Nebraska.

Professor A. R. Simpson has retired from the chair of midwifery at the University of Edinburgh after a service of thirty-five years. Professor Simpson was the nephew and successor in the chair of Sir James Young Simpson, the discoverer of chloroform as an anesthetic.

Dr. Otto Dimroth, professor of chemistry at Tübingen, has been called to Munich.

Dr. Alois Riehl, professor of philosophy at Halle, has accepted a call to Berlin.

Dr. Karl Isidor Cori, director of the Zoological Station at Trieste, has been promoted to a professorship of zoology at the German university at Prague.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, AUGUST 18, 1905.

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE RELATIONS OF ANIMALS TO DISEASE.[1]

A CONSIDERATION of the precise relation of various factors to the cause and spread of disease is of most recent origin. While popular superstition, more often false than correct, has recorded even in the most ancient history of medicine the source of various ailments, it is only within the last century that there has been any critical scientific study of the problem. Less than three score years cover the epoch-making investigations of Koch, Pasteur and their coadjutors which have laid the foundations and built up the already complex superstructure of bacteriology. By the efforts of these men the relations of minute plant germs, unicellular organisms which we call the bacteria, have been elucidated in great detail so as to justify a new theory of the origin of disease and a new and successful line of prophylaxis, or disease prevention. Similar studies have not been made in the zoological field, but recent discoveries seem to indicate the existence of important relations heretofore unsuspected and emphasize the hopeful character of this new field for research. In order to secure a comprehensive survey and place new items in their approximate position it is fitting to review in toto the relations in which animals stand to disease, restricting the inquiry, however, for evident reasons primarily to such ailments as affect mankind.

The simplest relation is manifested when

[1] President's address before the American Microscopical Society at the Cedar Point Meeting, delivered in the Carnegie Library Auditorium at Sandusky, Ohio, July 6, 1905.

the animal becomes a carrier of disease germs. This is a merely mechanical function and such disease-producing organisms as may be adherent to the body of the carrier are transported unwittingly from one point to a new environment where similar chance causes them to be deposited. In this way such germs may be distributed widely from an originally small focus and may be brought into inappropriate and unfortunate relations with members of the human species. A very large number of isolated cases might be cited to demonstrate such mechanical transport by animal carriers. One of the best known is the transport of typhoid germs by means of flies. The bacilli which are found in excreta adhere to the feet and hairs of the fly walking over such material, only to be carried by the next flight of the insect to a dish of food or pan of milk left standing on a table in the house or a bench at the door. In this new environment the germs may multiply and with it gain entrance to the new human host with disastrous results. Veeder has given a most vivid description of the unsanitary conditions which actually existed in our army camps in the Spanish American War and which demonstrated on a large scale this mechanical transfer of typhoid germs. Moreover, it can not be doubted that the bacilli actually are carried in such fashion, for in experiments reported in the transactions of this society, Maddox demonstrated that when such flies as have visited cultures of disease germs, walk over sterile gelatine plates they leave foci from which develop new colonies of bacteria of the specific sort. Experimental evidence is wanting which shall determine the actual extent of this infection, the distance to which such germs may be carried, and the length of time in which they remain alive and capable of producing an infection, as well as the other factors which control the importance of such mechanical transport. That it does play an important rôle can hardly be doubted, for to the numerous instances cited in 1899 in Nuttall's splendid monograph the intervening years have added both numbers and weight. To the instance already discussed where such transport was active must be added the passive transfer as of typhoid germs in oysters, which is well established.

It should not be inferred from the preceding that only typhoid bacilli are transported actively or passively by animal carriers. The germs of cholera, anthrax, septicemia, pyemia, erysipelas, tuberculosis and bubonic plague are said to have been transferred from one host to another in the same way. In some cases the evidence seems clear; in others a verdict of 'not proven' must be entered; and yet the observations already on record call for a most thorough investigation and extended experimentation in order to reach a final conclusion as to how widely the mechanical transfer of disease-producing bacteria may extend. In many cases it is doubtless purely accidental—casual—as in the hospital cases infected by flies which Leidy records in Philadelphia, or by mosquitoes as Giles notes in India. In such transfer of disease germs not only are flies the carriers, but also mosquitoes, bed-bugs, fleas, and other blood-sucking insects, though to a less extent, if present evidence represents fairly the actual conditions. Probably such carriers of disease will be confined chiefly to the insects and the passive agents will be exceedingly rare.

It has been observed, however, that such agents may transmit disease germs in other manner than merely adherent to the external parts of the body. Many experiments have demonstrated that various bacilli may pass unharmed through the intestine of the fly and be distributed with

the droppings of this insect to form centers of development wherever they chance to be deposited. More extended experimentation on this point is urgently needed, but one can hardly doubt that other insects, and perhaps many invertebrates, function in similar manner as distributors of infection. It should be noted that this manner of distribution is not confined to bacteria alone, although only scanty evidence is at hand concerning the mechanical transport of other forms. Thus Grassi found that flies sucked up with water eggs of various parasites, both tapeworms and round worms (*Tænia solium, Oxyuris, Trichuris*), and that these eggs were recovered unaltered from the dejections of the flies, while he also caught some flies with the alimentary canal full of these eggs. This is positive evidence that the fly is able to ingest solid bodies of some size through the sucking proboscis. At the same time he saw flies feed on the eggs of *Trichuris*, on his laboratory table, and later found the eggs in droppings deposited in the kitchen in the story beneath, at a distance of ten meters from the place where the insects had been feeding. Such internal transportation evidently insures far greater freedom from damage and adverse conditions, as well as much wider dissemination than were the spores or eggs merely adherent to external organs. Thus living cholera bacilli have been voided by a fly some days after the original contamination. In the course of this period of time the fly could have wandered to some distance from the place of infection.

Many investigations have shown, however, that small larvæ or adult worms like trichinæ are digested by the various animals to which they were fed, and have entirely disappeared in the course of a few hours. Such experiments have been made with frogs, salamanders, land and water beetles, maggots and earth worms. Stiles tried some years ago a most interesting experiment which throws much light upon this subject. He placed fly maggots with some *Ascaris lumbricoides* and the latter were devoured together with the eggs they contained. Not only the fly larvæ, but also the pupæ and the adult insects which developed from them were found to contain eggs of the Ascaris. As the experiment was carried out in very warm weather the Ascaris eggs developed rapidly and were present in the insects in various stages. Evidently then the adult fly would serve as a disseminator of the parasite, and if the eggs attained the proper stage of development the fly might infect man directly by depositing them on articles of food. It is known that certain seeds will develop only after having passed through the intestine of birds and it may well be that a similar biological environment is necessary in the case of some disease germs. Some such condition would serve to explain the curious inability to infect experimentally by direct transfer where the disease is yet readily and abundantly transferred in nature. But the transferring insect would not be a mere mechanical carrier, it would constitute a necessary link in the life history.

There are many such cases already known, but in most of them at least, the disease-producing organism passes through some phase in its life history in the disseminating animal which thus becomes an intermediate host, a necessary and not a casual element in the life cycle. Such forms are in no sense mechanical carriers and it is evident that the limits between these two groups depend partly at least on the extent of our knowledge, since a more careful investigation may show that some instances of transfer which are regarded to-day as purely mechanical involve in

reality more complicated relations. It is of the greatest importance that these relations be definitely established, for on them depends the introduction of a rational hygiene, and yet even the merely mechanical function of the fly in the dissemination of disease calls for strict measures to abate this nuisance. Any one may convince himself, even by superficial observation, that both individuals and communities through carelessness allow and produce conditions which breed enormous numbers of unnecessary flies. Rational hygiene calls for the removal of these conditions and the extermination of flies. Fortunately to-day one does not need to emphasize in civilized countries the undesirable character of bed-bugs, cockroaches and other vermin, which doubtless play a part in the mechanical transfer of disease germs, and probably are also associated more intimately with certain maladies, as will appear in the succeeding section.

Animals are also breeders of disease as well as carriers in a mechanical sense; and the part they play as breeders of disease may be either purely facultative or, on the other hand, essential to the spread of the malady. Regarding the facultative rôle of animals in breeding disease comparatively little exact evidence is at hand. It is somewhat generally maintained that various human diseases afflict certain animals, and the domesticated animals which stand in such close relations to man have been those against which, up to the present time, such charges have been most frequently made. The evidence is scanty, inconclusive and in some cases of no value at all; and yet one can not doubt that some of the germs which infect man do live also in other animals. Even among the higher animal parasites but few species are confined exclusively to the human host, and some, like *Echinococcus* bladders or *Trichinella*, may occur in a wide range of hosts. It is an important duty for the students of comparative medicine to determine to what extent disease-producing organisms may parasitize other hosts than man, for in this possibility lies the secret of the transmission and appearance at isolated points of new disease foci in some of the cases hitherto unexplained. It should be noted distinctly that when animals are facultative breeders of disease they merely afford a suitable ground in which the disease germs may multiply and an agency by which they may be distributed. Such animals are not in any way necessary to the existence or development of the germs; they only serve to increase the percentage of infection or the area of distribution characteristic of the disease. It is thus an important, but not an essential, rôle. Without question it plays some part, but how weighty its influence may be or in just what directions it may be exerted we are at present entirely unable to measure or estimate. This is unquestionably a most important and fruitful field for investigation.

In another sense also animals are breeders of disease, as when some part of the life history of the disease-producing germs is passed within the animal before that stage is reached in which the germ may infect a new human host. Here the relation is an essential one, and the intermediate host is a *condicio sine qua non* for the further spread of the disease. Such a relation is very widely known among animal parasites. The embryo of the sheep liver fluke, for instance, *must* undergo certain phases of development and reproduction within a snail before it reaches that form which can reinfect the sheep. The embryo of the unarmed human tapeworm *must* enter another host, the beve, and grow to a bladder worm, and this alone can

produce an adult tapeworm in the human alimentary canal. The embryonic round worms in the human blood *must* be drawn into the stomach of the mosquito, wander out into the thoracic muscles and grow to a definite stage of development before they can again enter the human host and become sexually mature adults which produce the blood-inhabiting embryos. In the case of malaria, the germs of *Plasmodium malariæ* *must* be drawn up into the stomach of the *Anopheles* mosquito, and within the body of this new host undergo a complicated series of changes before the new generation of spores is ready to be injected with the saliva into the blood of a man in whom these germs produce a new case of malaria. Not only is the intervention of a biting insect essential, and we know none other than the *Anopheles* mosquito which can 'fill the bill'—if you will allow the apparently appropriate expression—but it is equally true that the organism must pass through the complicated phases of its life history in the mosquito before the latter can infect. This is possibly even clearer in the case of yellow fever, even though the specific organism which is the cause of the disease remains as yet unknown. The mosquito which can transmit this disease is also a specific type, *Stegomyia fasciata,* designated often as the yellow fever mosquito. It acquires the power to transmit the disease by feeding on the blood of a yellow fever patient, but it can infect a non-immune person only after a period of ten to twelve days. Before that time the bite of this infected mosquito is harmless, and this condition can be explained only on the basis that the organism of the disease passes through certain stages in its development within the mosquito as a necessary preliminary to reaching the condition in which it is able to reenter the human frame and infect such persons as are susceptible. Until this period in the life history of the disease germ has been completed, the mosquito remains innocuous. On no other basis than this can the time interval be explained during which the mosquito does not transmit the disease, while after that limit has been passed the insect remains capable of infecting man up to the end of its existence, or at least more than two months.

The cases given illustrate in a representative way the phenomenon of alternation of hosts as it occurs often in the life history of parasites belonging to different groups of animals. In some cases the stay in the intermediate host is merely the occasion for growth and metamorphosis, as with the blood filariæ in the mosquito or the tapeworm embryo in the beef. But in other cases there is a reproductive period in this intermediate host, so that the change of hosts is associated also with alternation of generations or metagenesis. By means of this new generation the number of spores, eggs, embryos or other infecting units is markedly increased and the complicated and dangerous life cycle of the parasite finds its compensating factor in multiplied numbers. Among the arthropod parasites alternation of generations and change of hosts are rare; but among the parasitic worms both phenomena occur frequently. Thus all endoparasitic flukes, so far as the life history is known, manifest alternation of hosts and of generations; direct development has not yet been shown to occur in any tapeworm, although there is only rarely any new reproductive period in the life cycle. The round worms, or Nematoda, display every grade from the most extreme simplicity and directness of development and transfer to such complicated changes and wanderings as have even yet eluded the scrutiny of the closest investigator, or when announced have aroused the ridicule

of the scientific world on account of their improbability. As an excellent instance of these complicated relations may be cited the life history of the European hook worm, published by Looss, little more than a year ago. Looss has followed the migration step by step from the time the minute larvæ penetrate the hair follicles of the skin, enter a lymph space or a capillary to be carried by the current through the vessels ultimately into the right heart and from it into the lungs, where they desert the vascular system and migrate into the air cells, and then, wandering outward along bronchioles, bronchi and trachea, pass over the dorsal margin of the larynx and into the œsophagus, from which their pathway lies directly back through the alimentary canal to their final location in the small intestine. The migration requires ten weeks, during which time they pass through molts and grow in size, attaining the adult form and sexual maturity only after arrival at the end of the journey. Here the entire life cycle is passed in a single host, but its different phases are associated with various organs. In still other cases among the Nematoda a free-living generation alternates with the parasitic generation, instead of two kinds of parasitic generations which are found in different hosts.

Concerning conditions among the Protozoa there is less definite knowledge of the life history than among the higher groups, but instances of all the conditions cited for the worms may also be found here. Some species undergo direct development, others make a single or even a double change of hosts, and in some two generations of different type alternate in the complete life cycle of the organism. Thus the amœba of tropical dysentery (*Entamœba histolytica*) seems to develop directly; the blood amœba of malaria (*Plasmodium malariæ*) goes through an asexual reproductive cycle in man and another, the sexual cycle, in the mosquito. In this case we know that the mosquito is not the mere mechanical carrier of the disease germ, but that it is a necessary link in the life history, a breeder as well as a transmitter of disease. Regarding the rôle of the cattle tick in Texas fever, it may be inferred with great probability that it plays a similar part, even though the history of the parasite within the tick has not yet been worked out. In other diseases, such as sleeping sickness, where the parasite, a flagellate protozoon, known as a trypanosome, is transmitted by a biting fly, familiarly called the tse-tse fly, there is less evidence on which to base a conclusion. The tse-tse fly may be purely mechanical in its intervention; it seems more probable, however, that it plays a more intimate part. The instance shows very clearly, however, that until the life history has been elucidated, it is impossible to determine the relative importance of any element in the series, or intelligently to combat the disease which evidently should be attacked at its weakest point. This factor will be considered more in detail later on.

But animals also stand in a causal relation to disease; certain forms are definitely shown to be producers of disease and in this aspect demand especial consideration. This fact has been generally recognized in the case of a few parasites from the earliest days of medical history. The fiery serpent of the wilderness was no doubt the guinea worm, of which the most ancient medical writings make note; and in this instance not only the cause of the malady, but also the general mode of infection through drinking water, and the method of cure, the removal of the worm, were known to the Egyptian as well as to the Greek physicians. But such instances are rare. Re-

garding merely even the larger, more conspicuous parasites of man the wildest ideas were current as to their origin and their effect on the system. Thus tapeworms were supposed to originate from thickened mucus, or from an abnormal condition of the alimentary canal; and various parasites were from time to time regarded as the causes of cholera, typhoid and other similar diseases. Such views as these prevailed generally even less than a century ago, and it is not strange if, in consequence of more accurate knowledge on these points and of the rejection of such wild theories of disease, the pendulum has swung to the opposite extreme and animal parasites have come to be considered of insignificant importance in the etiology of disease.

Two factors tended to strengthen this view and further belittle the possible rôle of animals as disease producers. In the first place, with the possible exception of malaria, no animal organism was known to be the cause of any general disease; and while the animal nature of the *Plasmodium malariæ* was never doubted in any considerable circle, the case stood so evidently isolated that it emphasized all the more its own peculiarity. But even more powerful than this was the rise of a new science, bacteriology. Certain minute plant germs had been found to be the cause of decay, why not of disease? In response to the needs of the case there arose a new technique for handling and studying these forms, a rigorously analyzed series of conditions for determining their possible relation to disease; and a new field of science was organized. Discoveries followed one another with marvelous rapidity and every year saw the elucidation of the cause of new maladies. It seemed as if the secrets of disease had been laid bare; men had traced the causes to bacteria in many cases with such success that they continued to follow the same line in other yet unexplained diseases, confident that there was only some minor defect in technic which would soon be overcome and the solution obtained. Indeed, the very name disease germs was regarded as equivalent to bacteria. There is no doubt that success in this direction served to draw attention away from the signs which presented themselves in other fields and particularly to minimize the animal organism as a causal factor in disease. Recent discoveries of great import which have crowded hard upon each other are disclosing here a new field and stimulating the investigation of neglected territory. Let us now examine seriatim the different groups of animals to secure a clear idea of the rôle played by each in the production of disease.

The disease-producing organism works slowly, insidiously, saps the vigor of the infected individual without consuming the substance so as to destroy life by immediate destruction of the body. It is clearly not carnivorous, but rather parasitic in habit; consequently among the vertebrates as well as among the largest and most powerful invertebrates, one could not expect to find such forms. These largest species might be carriers of disease or even breeders of sickness, but they could not constitute the immediate cause of the malady. It may be interesting to note in passing an apparent exception to this rule. The lamprey eel attaches itself to other fish and is directly the cause of the ulcers on the skin which mark the points of the lamprey's fixation, and of the anemia which follows its blood-sucking and often induces the death of its host. But this instance stands alone.

In the great majority of cases the disease producers are small organisms or at least gain their entrance into the body of the host in a form so minute as to defy detec-

tion. The arthropods furnish many carriers of disease and breeders also, as the extended references already made to these forms suffice to show. The more or less perfectly acquired external parasitism of these forms is admirably adapted to these functions, but such animals are not the immediate cause of disease, and when sickness follows a bite of a fly, a spider or a tick, the effect is more probably due secondarily to the bite and primarily to some other organisms introduced thereby.

In the case of the parasitic worms the conditions are decidedly changed. Here are species which parasitize within the body, often suck the blood of the host, lacerate delicate mucous membranes, induce internal hemorrhage, in some instances feed upon the cells of the tissues, and destroy important organs or grow to such size as to encroach upon normal structures and functions. In addition to these anatomical interferences, some of the parasitic worms are known to produce waste matter in their own biological processes, *toxins*, which act deleteriously upon the host organism and evoke abnormal and serious symptoms in it. Thus Vaullegeard has isolated experimentally from tapeworms two chemical substances which act upon the blood and nerve and which, injected into experimental animals subcutaneously, produce the epileptic symptoms that characterize severe cases of tapeworm infection. Then the physician speaks of a *Bothriocephalus* anemia, recognizing a definite group of symptoms, a distinct disease produced by the parasitism in man of the broad fish tapeworm (*Dibothriocephalus latus*). Here the animal is the immediate cause of the disease and the removal of the tapeworm is followed at once by the disappearance of the undesirable symptoms.

While there are some animal parasites which are believed to be harmless, or, better expressed, do not do any damage to the human system so far as present knowledge extends, yet the studies of recent years have furnished constantly increasing evidence of the pathogenic rôle of these organisms. They do damage indirectly by irritating the delicate mucous membranes and by lacerating them, thus giving access to the omnipresent bacteria, a danger which has been greatly underrated. But they are also the direct cause of disease which in consequence of their part in its production the physician names after the species of parasite, as trichinosis, uncinariasis, hydatid disease, etc. Note further that they are not factors of trivial importance in general hygiene or of little bearing upon the welfare of a nation as a whole, and that a large percentage of such diseases can be treated only by preventive medicine. Thus trichinosis, which is caused by eating pork containing living trichinæ (*Trichinella spiralis*), is accompanied by a high mortality and even yet is a serious disease in northern Germany; its prophylaxis is, however, exceedingly simple and no one who is careful to avoid underdone pork will ever suffer from its attacks. Again, hookworm disease, or uncinariasis, has been shown by the researches of Stiles and others to be very abundant in certain parts of our southern states. The presence in the alimentary canal of myriads of minute hemorrhages caused by the action of these worms, results in a chronic anemia which prevents the attainment of physical or mental development, stunting the individual and leaving him, on arrival at years of maturity, little more than a child in body and in intellect. Much of the degeneracy of the poor white trash of the south is due not to inherited defects or to family shortcomings so much as to the presence of this parasite, which from early childhood has continually sapped the vitality of the indi-

vidual. It needs no extended argument to demonstrate the sociological effect of the recognition and removal of this one cause of disease. Nor will any one doubt the desirability, yes, the necessity, for a careful investigation into the life history and effects of these parasites. For from the life cycle is to be obtained the clue to the means of attack, to the weak spot in the armor of the disease on which its ultimate destruction depends; and every one recognizes as the ultimate goal of medicine as a science the eradication of such diseases that the physical man may move forward toward the possibilities in perfect development with which he is endowed.

That which I have outlined has been known in part for many decades, even though the investigations of recent years have contributed much toward a clearer comprehension of the question. Among the Protozoa, however, the last few years and even months have brought discoveries of the most startling character regarding their relation to disease. It was in 1890 that Laveran first discovered the amœboid parasite in the red blood cells now universally recognized as the cause of malaria, and not until 1899 was its life history clearly outlined, while even yet some minor details of the picture are lacking. Since the opening of the new century there has come the demonstration of the cause of sleeping sickness, a terrible disease of tropical Africa, in a flagellate protozoon (*Trypanosoma*) other species of which in the blood of various domestic animals have been shown to give rise to widespread and fatal epidemics in other countries; the parasite of smallpox has been found to belong to this same group and its life history has been determined partly at least. The disease known as kala-azar, dum-dum fever, or splenomegaly, a fatal malaria-like malady of India and Africa, has been traced to another protozoon parasite; in yellow fever it seems probable that such organisms are the exciting cause; in various other diseases they have been seen, even though in some cases subsequent investigation has failed to demonstrate the parasites and confirm the reports; and finally within this year accounts by well-known German investigators proclaim the discovery of the cause of syphilis in a hitherto undiscovered protozoon of the order of flagellates. In all of these maladies the bacteriologists have been searching with great care for the etiological factors, but their efforts have been fruitless. It is apparent that the new field will demand its own technic, and until that has been developed and the proper standards of judgment formulated, much work will necessarily go to waste and many errors be committed.

These organisms, the unicellular animals, are distinctly analogous to the unicellular plants, among which the bacteria stand as the characteristic disease producers. Indeed, the recent studies have shown that one genus, *Spirochœte,* long known and hitherto classified among the bacteria, is probably not such, but rather a flagellate protozoon. And possibly other genera of Protozoa are also wrongfully assigned to bacteria. On the other hand, zoologists have long recognized certain forms of Protozoa as pathogenic, producing disease among the various other animals, and this is at least an indication of their filling a similar rôle in the human body.

In consideration of these facts it is not unreasonable to believe that we stand now at the opening of a new field which is to make of itself in the future what bacteriology has made in the last half century. There is need of a Pasteur, a Koch and their confrères to lay the foundations strongly and to analyze with equal sharpness the relation of these animal micro-

organisms to disease. Even now the new field has been recognized and the Landon School of Tropical Medicine has appointed this year an investigator in protozoology—however unfortunate the form of the term may be. There are already listed more than thirty of the Protozoa which parasitize the human body. Regarding many of them our knowledge is exceedingly scanty, but of others it may be affirmed definitely that they are the cause of diseases which rank among the most dangerous to which man is subject. Among these forms I have included only those that are distinctly recognizable in structure as Protozoa, though their life histories and exact relationships are yet unexplained; but beyond these limits lie a vast horde of unidentified structures, interpreted by some observers as parasitic protozoa, but regarded by others as parasitic fungi and by still others as products of cellular degeneration or other pathological changes. Such are the cancer parasites of several investigators, the organisms of leucæmia, scarlet fever and other diseases. No doubt some of these will be shown by further research to be in fact independent organisms of parasitic habit and the cause of disease, and it seems probable that many of these will fall within the group of Protozoa, the unicellular animals. Thus has been opened up a new field in which the microscope is the essential instrument of investigation. All the work to be done here depends upon this instrument, without which the very existence of these organisms would have remained unsuspected. Following close upon the wonderful discoveries of the histologist, the pathologist, the bacteriologist and the clinician, these studies furnish new evidence of the supreme importance of the microscope in the development of scientific medicine, in the attainment and preservation of the health of mankind.

There is left but a paragraph in which to mention another aspect of the subject of this address. Even under the narrow limits of the topic—animals in relation to disease—there is one phase which in justice to them should not be entirely omitted. Animals stand also distinctly as preventers of disease; and this in the first place as destroyers of disease germs. Among the Protozoa which have already been exploited as the producers of disease, are found also the organisms which play the most important part in the purification of sewage-contaminated streams by consuming the bacteria. These forms are specifically ciliates, of which the common slipper animalcule (*Paramecium*) may serve as a typical form; they abound in all waters, especially in those containing decaying matter, and devour countless numbers of bacteria. Through their activity it becomes possible for one city to drink the diluted sewage of another city higher up on the watershed without losing all its citizens from intestinal diseases.

Modern science has also made use of animals in combating disease; as producers of antidotes, either in the form of cow-pox or vaccine, or in the rôle of test animals and of serum producers, manufacturing antitoxines of various sorts, many animals discharge in this way a most essential function in modern life. But the discussion of this phase lies beyond the demands of the present occasion.

In closing let me call your attention to the bearing these studies on the relations of animals to disease have on the science of medicine. Any rational method of cure depends upon the distinct recognition of the cause of the malady. Any other basis gives unlimited opportunity for chicanery and fraud and for the despoliation of the people in the name of medicine, so general to-day. But more than that, preventive

medicine is to be the ultimate product of the scientific studies of to-day; no one can question that it is a far higher and more desirable type than curative medicine that now generally seeks to remedy the ills begotten through ignorance. The loss to the world by preventable disease is enormous; it includes many of the wise and the good, of the best products of human evolution during past centuries, for no selective action determines that the worse element shall be wiped out. In truth, the delicate nervous balance of the highly developed human organism seems to be more easily disturbed by the attacks of disease than the grosser clay in which all energy has gone to physical development. To stop this loss is the greatest problem of the future in medicine. And the very first step in this problem is the positive determination of causes of disease, and of the means by which they are transmitted and multiplied. Without this knowledge rational prophylaxis is impossible; before it and the results of associated investigations of purely scientific character, quackery must yield as the night before the day, schools and theories will disappear and medicine will take its rightful place among the sciences.

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SCIENTIFIC BOOKS.

The Dynamics of Particles and of Rigid, Elastic and Fluid Bodies. By A. G. Webster. Teubner & Co. 1904.

The training of the physicist and that of the engineer are subjects which one can hardly refrain from discussing whenever a new volume designed to furnish some part of the necessary equipment for either appears on the scene. The one which is the subject of this review raises the question in a much more definite way than anything which has appeared for some time past. Most of the books hitherto published are either mathematical treatises on special departments of physics, or are physical text-books in which mathematics are avoided as far as possible. Professor Webster has attempted, as we shall see later on, to combine the two points of view, somewhat on the lines of Thomson and Tait's 'Natural Philosophy,' but better adapted than that work for the class-room.

The latter part of the nineteenth century has seen a far-reaching change passing over those subjects which deal directly with the interactions of particles of matter. Much careful experimental work has been done and laws and principles have been formulated with such accuracy that the time of the all-round physicist has now to be spent as much at the desk as in the laboratory. In spite of this change, the training of the student is still largely devoted to experimental work and the accumulation of facts. But few students realize that the phenomena can nearly all be brought together as the effects of the operation of a few simple laws. They spend so much time and labor in mere manipulation that the end is quite lost sight of in the means. As a matter of fact, many of the earlier experiments are made with highly specialized forms of apparatus and could be quite easily replaced by illustrations to be obtained from the machinery which has become an essential part of the daily life in all civilized communities. A great saving of time, to be better employed in other directions, might be made by thus laying on a foundation which already exists, and the training would be directed towards the principles and the way in which the laws are manifested rather than to the mere effects themselves.

There is, of course, a difficulty which is always present in the mind of every teacher—that of retaining the interest and holding the attention of the student. Comparatively few of the latter take an interest in the methods, chiefly mathematical, by which the phenomena are deduced from the general laws, and these few frequently neglect the physical side entirely. And yet it is only by a combination of theory and experiment that the best results can be obtained. It is useful for a mathematician to have a knowledge of physics, but it is necessary for a physicist

to have such a grasp of mathematics that he is able to work out the problems which arise in connection with his experiments. As Professor Webster points out in his preface, there has been far too much neglect with us of the mathematical side, and while this neglect continues we can scarcely hope to produce men of the type of Maxwell, Kelvin, Rayleigh, Helmholtz and others.

In considering, then, the training of the physicist no less than that of the practical engineer, it is necessary to keep two points steadily in view. The first is a full understanding of the primary laws which lie at the basis of all physical investigations, and the second is the ability to apply those laws to specific cases. Simple as are the laws and the methods of applying them, only those who have attempted to teach the subject know how difficult it is for even the best students to acquire a thorough working knowledge of them and how rare it is for the average student to solve the simplest problems when the latter are anything more than mere applications of results previously obtained. The ability to do this is usually obtained only by long practise, and the time at present devoted to acquiring the facility necessary for success is quite inadequate. To take a simple example. Most of the volumes on the calculus which are written solely for students of engineering and physics contain nothing more than the parts which are necessary to understand the mathematics used in solving physical problems. No thorough grasp of the subject is obtained in this way; the student obtains knowledge sufficient perhaps to understand what is presented to him in a finished form, but there is no margin left for independent work on problems which lie a little off the main track.

Professor Webster has fully recognized this fact. It is true that he presupposes only an elementary knowledge of the calculus and of the earlier parts of algebra and analytic geometry, but a student who wishes to make a serious study of the book will require to know these earlier parts thoroughly. Throughout the volume there is no attempt to slur or evade any difficulties because they are mathematical; practically every result obtained is fully worked out and in many parts the author takes his reader far beyond what is merely necessary. Moreover, he never allows himself to be drawn away from the main lines of his subject by side issues which have little or no bearing on the investigation in progress, and he has avoided the use of special mathematical artifices which are of value only in special problems, so that the methods used are those which can be applied to practically all the problems of dynamics.

Part I. consists of the development of the general principles of dynamics. In the first chapter the elements of kinematics and the laws of motion are briefly set forth. Then follows a chapter on special motions of a particle, which include parabolic, harmonic and constrained motions, pendulums and central forces. Professor Webster has avoided the doubtful practise of most of the English text-books which give a disproportionate amount of space to the last, but the eight pages on the spherical pendulum, although the problem is well worked out, might perhaps have been abbreviated by the omission of some of the figures and details. The next two chapters contain an unusually full development of the principles of work and energy and the methods of Lagrange and Hamilton. Here we find worked out, first, by the use of rectangular coordinates, and afterwards with generalized coordinates, D'Alembert's principle, canonical equations, least action, varying action, varying constraint, activity, etc. These chapters are important in view of the increasing prominence now given to methods which are of value in every department of mathematical physics, as Professor Webster shows by his use of them in the later parts of his book. This first part concludes with applications to oscillations in general and to cyclic motions. In dealing with the latter, special cases of the general methods of abstract dynamics are treated: ignoration of coordinates, effect of linear terms in the kinetic potential, gyroscopic terms, and so on. A few examples are worked out to illustrate the manner in which the various methods are to be used.

The second part deals with the dynamics of rigid bodies. The author here develops, with considerable detail, the mechanics of systems which admit of representation by means of vectors, a method used throughout the volume wherever possible. Under this head come screws and wrenches, moments of inertia, and the special kinematics of a rigid body rotating about a fixed or moving point. Special attention is devoted to the dynamics of rotating bodies. The top comes in for detailed treatment and many of the curious phenomena exhibited are deduced from the equations of motion. Pictorial illustrations are given of the instruments and of the curves which have been actually obtained by the author to show how closely observation may be made to agree with theory.

The third part opens with a chapter on the Newtonian potential function. This will probably be found to be the least satisfactory in the whole volume from the student's point of view. Although it may be quite logical to start with the properties of point-functions and develop them in detail before proceeding to the applications, it is frequently tedious to read through many pages of mathematics leading to isolated geometrical results without indications of the uses to be made of those results. A rearrangement in which concrete problems are stated and solved, gradually leading the student step by step to each new mathematical investigation as he sees the need for it, would seem to better achieve the end the author has in view and would avoid the danger of wearying the student and losing his interest. The next two chapters contain the dynamics of deformable bodies. The theory of stresses and strains is worked out and the illustrations are derived chiefly from problems in hydrostatics and hydrodynamics. The final chapter on the latter is perhaps the most interesting in the book. After obtaining the general equations of motion, the author treats briefly, but sufficiently for his purposes, vortex motion, including tidal problems and sound waves. An appendix contains notes on certain portions of algebra and analytic geometry.

It is to be regretted that a little more care has not been exercised in the wording of the statements and definitions, especially in the earlier parts. For example, in the statement of the second law of motion, Newton's 'change of motion' should be paraphrased 'rate of change of momentum,' and not 'acceleration.' On page 31, the reason for the necessary slight modification of Kepler's third law is given as due to the motion of the sun, instead of to the fact that the mass of the planet is not infinitely small compared with the mass of the sun. On page 35 the impression is conveyed that a motion is periodic when a system is in the same *position* after a certain interval of time, whereas it must also have the same *velocities*. It is not clear what is meant by the statement on page 96 that the principles of conservation of energy, of the motion of the center of mass, and of moment of momentum 'suffice for the treatment of all mechanical problems.' On page 131 it is stated that Jacobi's dynamical method furnishes a means of integrating the equations of motion of a dynamical problem; this method is really a transformation which replaces the problem of solving $2n$ ordinary differential equations each of the first order, by that of solving a partial differential equation of the first order in $n+1$ variables.

Whatever criticisms we may be disposed to make on minor points, we can heartily congratulate Professor Webster on having produced a book which is in many respects a notable contribution to the literature of the subject. Even if it served no other purpose than to draw the attention of students and teachers to the necessity for a more profound study of the mathematics of physics, it will have achieved useful results. As a class book with an efficient instructor, it will be found to be of value for students who have had a fairly good training in algebra, the calculus and elementary mechanics, and who wish to go further either in experimental work or in the mathematics of physics. It will also be found useful as a place of reference for the main outlines of the various subjects treated.

We hope that Professor Webster's work will be the forerunner of other volumes on similar lines intended not to replace, but to be read in

conjunction with, the well-known treatise of Thomson and Tait.

ERNEST W. BROWN.

DISCUSSION AND CORRESPONDENCE.

ON THE SPELLING OF 'CLON.'

TO THE EDITOR OF SCIENCE: The original orthography of 'clon' should be retained, in the opinion of the present writer, for the following reasons: '*Clone*,' the form preferred by Mr. Pollard (SCIENCE, XXII., p. 87), is already in use as a medical term, and is of different origin and significance from *clon*. If the latter word should take final *e* in order to mark an omega sound in the original, so also should eon, pæon, autochthon, halcyon and similar words in common use.

Linguistic usage does not require, however, that loan-words and derivatives from other languages should always preserve the same vowel quantities, and in transliteration from the Greek no distinction is made between the long and short sounds of *o* and *e*. In fact, η and ω were unknown until the introduction of scholastic writing, and remained long afterwards confused with ϵ and o. Final *e* in English derivatives may stand for a distinct syllable in the original, as in the other examples given by Mr. Pollard, or may be added for euphony, but not for the sole purpose of indicating quantity. Sometimes the final vowel is arbitrarily syncopated, whence the resulting variants of metaphor and semaphore, plasm and plasma, hypogyn and hypocrite, rhyme and rhythm, etc.; or we may even write both synonym and synonyme, though the latter form is antiquated.

Scarcely germane to this matter, but suggested by it, is the popular habit of miscalling under a variety of un-English names one of the most famous masterpieces of Greek art. When we say 'Milo,' we are merely following the continental pronunciation of Melos, in which the final *s* is no longer sounded. *Venus de Milo* is the French name of the statue, Aphrodite of Melos the correct English name. The most unpardonable combination of all is 'Venus of Milo,' with the long (English) sound of the *i* in Milo; for in the first place, the Italian goddess is not the precise equivalent of Aphrodite, and in the second place there is no such geographical name as 'Milo,' at least, not in Greece.

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SPECIAL ARTICLES.

THE LAWS OF EVOLUTION.

THAT account of universal evolution which we owe to Mr. Herbert Spencer may be supplemented by a formulation of certain quantitative laws which Mr. Spencer seems not to have apprehended. Mr. Spencer's own so-called 'Law of Evolution' is in reality only a great generalization, and not in a stricter sense of the word a law at all. It tells us that everywhere the loss and redistribution of the internal motion of a finite aggregate are accompanied by the concentration or 'integration' of mass, a 'differentiation' of arrangements, forms and activities, and a 'segregation' or drawing together of like units. It does not tell us anything about the rate or amount of 'compound evolution' to be expected from any given expenditure of energy under given conditions.

Economists have long been familiar with certain laws of differential cost and gain. They are commonly called laws of increasing and of diminishing return. The usual statement of them in the text-books is inadequate. A more accurate, and possibly a sufficient, statement is, that in any given state of industry and the arts, an increasing outlay of labor and capital in agricultural, manufacturing, or commercial operations conducted upon a given area,[1] will, up to a given limit, yield returns increasing faster than the outlay, and will, beyond that limit, yield returns increasing less rapidly than the outlay.

In the course of my sociological studies I have been led to believe that increasing and diminishing returns, within the realm of economic phenomena, are only special cases of relations that hold good throughout all phenomena, physical, chemical, biological, psychological and social. In a future publication I hope to set forth the grounds of this

[1] Observe, *space* not 'land.'

belief, and to show that the laws of increasing and diminishing return are universal laws; in other words, that they are laws of universal evolution. In the present article I attempt only to offer a tentative formulation of these laws, and to present a few of the more obvious and important explanations that they suggest of certain specific phases of evolution, such as natural selection and survival.

In the evolutionary process 'outlay,' instead of being made in terms of labor and capital, as in industry, is made in expenditures of energy, that is to say, in dissipations of motion. The 'return' for this outlay is the total amount of compound evolution. Under certain conditions an increasing expenditure of the energies—original and subsequently acquired—of an aggregate, results in evolutionary changes that extend or multiply more rapidly than the expenditure of energy increases. Under other conditions, evolutionary changes extend or multiply less rapidly than the expenditure of energy increases.

Chief among the conditions here referred to as determining the rate of evolutionary change, the important ones are, first, the heterogeneity of the elements or materials entering into the aggregate, and, secondly, the kind or quality of the materials.

In homogeneous bodies or aggregates concentration bears a constant ratio to the loss of internal motion, but in heterogeneous bodies there is no such constant ratio. Concentration may proceed more or less rapidly than the loss of energy, according to the composition of the mass.

Different forms of matter differ one from another in their capacity to contain motion with a given concentration of their particles. That is to say, they differ one from another in energy-storing, energy-conveying and energy-transforming capacity per unit of volume and weight, as is seen, for example, in the unequal capacity of woods and metals to convey heat or to transmit electricity.

The general laws which formulate the relation of these facts to the rate of evolution are these:

1. In a heterogeneous aggregate the amount of transformation, *i. e.*, of compound evolution, increases more rapidly than the dissipation of motion if, in the composition of the aggregate, materials of a higher are being substituted for materials of a lower capacity —per unit of weight and of volume—to store, convey and transform energy, and are being maintained in a perfect working correlation.

2. Conversely, the amount of compound evolution increases less rapidly than the dissipation of motion if, in the composition of the aggregate, materials of a lower are being substituted for materials of a higher capacity —per unit of weight and of volume—to store, convey and transform energy, or if they are not maintained in perfect working correlation.

Two or three simple illustrations derived from economics must here suffice as examples of innumerable facts upon which the demonstration of these laws rests.

Increasing the returns of a factory of given floor space by increasing the speed of machinery is possible only if for mechanisms of poorer quality there are substituted boilers, shafting, gearing, etc., of great cohesive strength, and great tensile strength in proportion to weight and volume.

The increasing returns of a department store, in proportion to capital invested, have been made possible by the substitution of such devices as the light and diminutive cash carrier apparatus for the relatively clumsy mechanism of a sufficiently large staff of men and women, or boys and girls, to perform a like function.

The mechanically and commercially possible 'skyscraper' has been made possible by revolutionary changes in building materials and construction, including a substitution of light, but immensely strong, steel frames supporting the outer walls as well as the flooring, for massive outer walls supporting an internal structure.

These laws of evolution are, I think, the basis and explanation of the phenomena of natural selection and survival.

In any finite aggregate of competing things or organisms, those survive in which the total amount of evolutionary transformation in-

creases more rapidly than the net expenditure of energy; those perish in which the total quantity of evolutionary transformation increases less rapidly than the net expenditure of energy.

These laws of evolution and of survival are exemplified in biological evolution both in the constitution of organic matter itself and in the paleontological series.

In all organic matter we find marvelous strength, and marvelous capacity to store and to transform energy, in proportion to weight and volume.

In the paleontological series we see the termination of the line of monster organisms, and the rise and survival of organisms of less weight and bulk, but of higher biological quality.

In psychological evolution the superimposition of reason upon instinct is correlated with an increasing complexity of nerve and brain structure, the marks of which are a finer and finer cell mechanism, of enormously high energy-conveying and converting capacity in proportion to weight and volume.

In the competition of human races one with another, and of population aggregates one with another, those of high energy-storing and converting capacity per individual have occupied the superior environments, and have most vigorously multiplied.

In the evolution of social organization superior corporate forms displace inferior forms only if with a differentiation of departments, a multiplication of officials and a specialization of functions, there is a corresponding improvement in individual efficiency.

FRANKLIN H. GIDDINGS.
COLUMBIA UNIVERSITY.

ALTERNATION OF GENERATIONS IN ANIMALS.

IN SCIENCE of April 28, 1905, Professor Harold L. Lyon attempts to criticize my paper on 'Alternation of Generations in Animals from a Botanical View-point' (*Botanical Gazette* 93: 137–144, 1905). My theory, stated briefly, is this: The egg with the three polar bodies constitutes a generation comparable with the female gametophyte in plants; similarly, the primary spermatocyte with the four spermatozoa constitutes a generation comparable with the male gametophyte in plants. All other cells of the animal constitute a generation comparable with the sporophytic generation in plants, the fertilized egg being the first cell of this series.

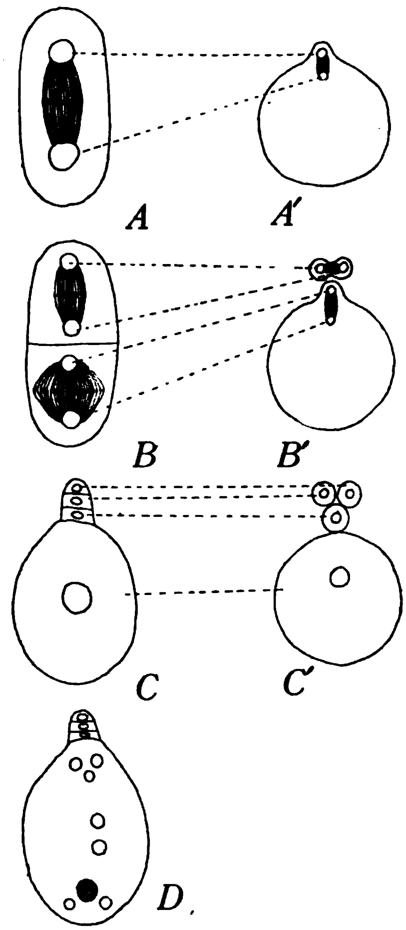

FIG. 1.

According to Professor Lyon, my diagrams indicate "that the animal egg by itself and each spermatozoid is comparable to a plant gametophyte. His statements are not consistent, not in accordance with the facts or even with his figures, and it appears that just where he wishes to draw the homology is not quite clear in his own mind."

Such a positive and dogmatic criticism should be accompanied by some proof, but the

proof does not appear. Fig. 1 is the diagram which Professor Lyon fails to reconcile with the statement just made in the first paragraph of this note. Just why he failed to grasp the situation will be evident to any morphologist. He simply failed to distinguish between a *gametophytic generation* and an *individual gametophytic plant*. According to Strasburger[1] the spore mother-cell is the first cell of the gametophytic generation. This spore mother-cell usually produces four spores, each of which, with or without germinating, is an individual gametophytic plant. In Fig. 1, *C* and *C′*, this condition is compared with the egg and the three polar bodies. In the same figure, *B* and *B′*, and *A* and *A′* show previous stages in the development. A stage preceding *A* and *A′* might have been added to compare the spore mother-cell with the primary oocyte. The diagram is intended to indicate not only that the entire gametophytic generation in plants is comparable with the entire gamete-producing generation in animals (this generation beginning with the primary oocyte and ending with the egg and three polar bodies), but also that each of the four megaspores is comparable with an animal egg, the three polar bodies, of course, being regarded as eggs. I am aware that some cytologists, notably investigators of the Grégoire school, are questioning whether the gametophytic generation does not begin with the spore rather than with the spore mother-cell, since it is not until the spore is reached that the reduced number of univalent chromosomes is found. This, however, is a minor detail which does not affect essentially the theory presented in Strasburger's paper on periodic reduction or the theory advanced in my paper on alternation of generations.

The remark 'That zoologists recognize an alternation of generations in Hydrozoa and Scyphozoa is a common statement of their text-books,' coming from a teacher of botany, is rather surprising. We shall take a charitable view and hope that it was ignorance of zoology rather than of botany that allowed the remark, for the condition in Hydrozoa described by zoologists as an alternation of generations is not an alternation of generations in the botanical sense, but is only a case of polymorphism, the relation of the medusa form to the parent plant being somewhat like the relation of the leafy moss plant to the protonema. Since my paper appeared, several zoologists have called my attention to this alternation of generations in hydroids, but they have recognized at once that the term, alternation, is used in a totally different sense by botanists and zoologists.

[1] Strasburger, Ed., 'The Periodic Reduction of Chromosomes in Living Organisms,' *Annals of Botany*, 8: 281–316. 1894.

The general criticism that there is no evidence in favor of my theory, would require a long answer. In replying to zoologists who have written to me and in explaining my theory more fully to zoologists whom I have met, the series of diagrams shown in Fig. 2 has been useful. The diagrams and explanations are given, not as a reply to Professor Lyon, but as a general answer to those who have asked about the progressive reduction of the gametophyte. While the series does not prove that the egg with its polar bodies constitutes a reduced generation comparable with the gametophytic generation in plants, it does indicate how a condition quite strictly comparable with the animal egg and polar bodies has been reached by the gametophytic generation in plants.

In Fig. 2 the smaller diagram at the right in each case represents the egg and the three polar bodies.

In an homosporous fern (Fig. 2, *A*) each of the four spores derived from the mother-cell may form an independent plant. Four gamete-bearing plants are shown. Professor Lyon's confusion probably arose from his failure to recognize that the gametophytic generation could include anything more than just one of these four plants. According to Strasburger's theory, which is more generally accepted than any other, the gametophytic generation includes not only all four plants with their eggs and sperms, but also all preceding stages back to the mother-cell.

The water ferns (Fig. 2, *B*) are heterosporous and only one of the four megaspores produces a mature plant, the other three becoming

abortive. The plant is largely confined within the spore. The protruding portion may develop more or less chlorophyll and, consequently, is not completely dependent.

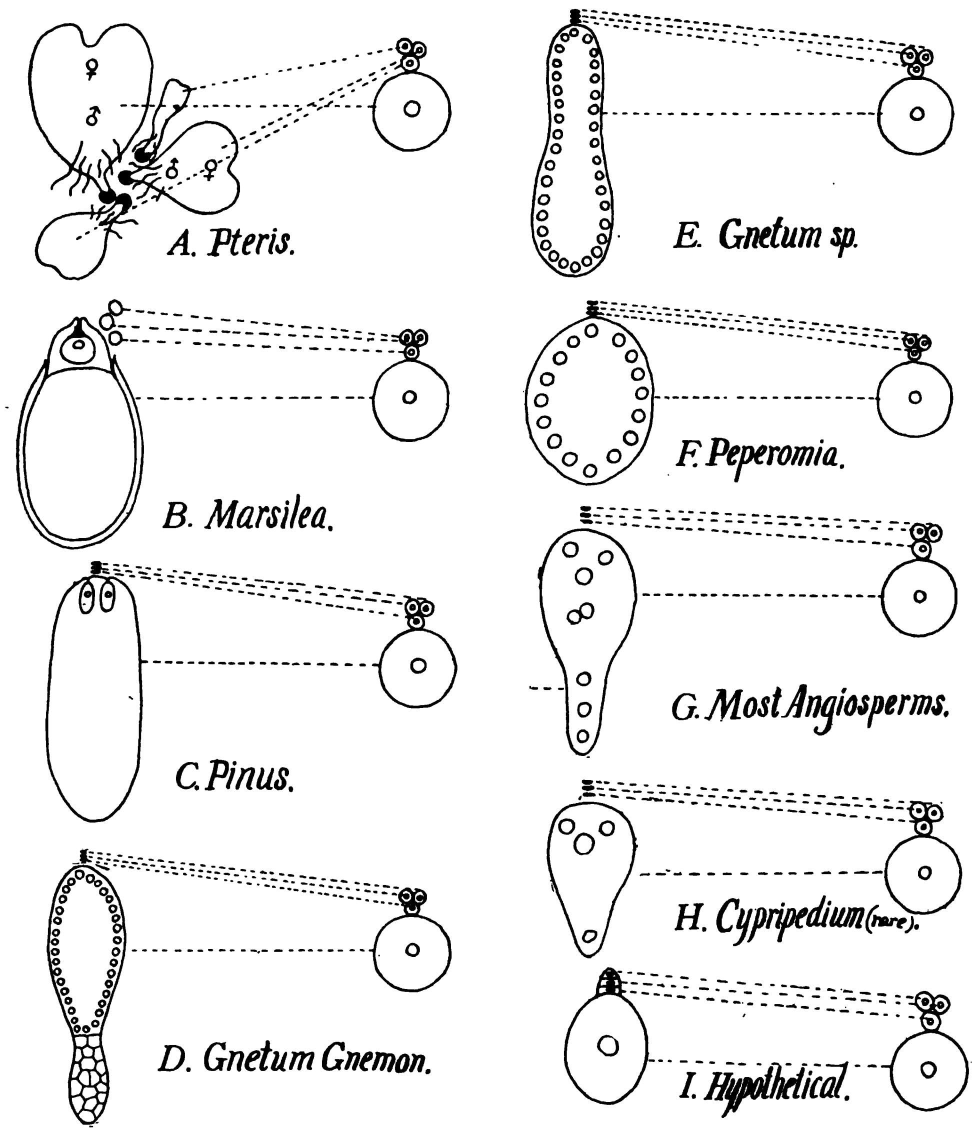

Fig. 2.

The gymnosperms (Fig. 2, *C*) are heterosporous and, as a rule, only one of the megaspores germinates, the other three becoming abortive.[3] The germination is entirely intrasporal and the resulting plant is entirely parasitic. Further, the spore, with its contained plant, is never shed from the enclosing structures. At the beginning of germination there is a prolonged period of free nuclear division, but later, cell walls are formed and at the stage shown in the diagram the plant consists of a solid cellular tissue.

[3] The three abortive megaspores are represented in C — H of the diagram by three heavy lines, although they disappear completely before the stage shown in the diagrams has been reached.

In *Gnetum Gnemon*, a gymnosperm (Fig. 2, *D*), cellular tissue is formed only at one end of the female gametophyte, the end nearest the micropyle remaining in the free nuclear condition. Any one of these free nuclei may become an egg nucleus.

In other species of *Gnetum* (Fig. 2, *E*) no part of the female gametophyte gets beyond the free nuclear condition. The number of nuclei is likely to be smaller than in *Gnetum Gnemon*.

Peperomia, an angiosperm (Fig. 2, *F*), shows a still more reduced condition, the mature female gametophyte containing only sixteen free nuclei. A somewhat similar condition is found in *Gunnera*, where the number of free nuclei varies from sixteen down to eight.

Most angiosperms (Fig. 2, *G*) have eight nuclei in the female gametophyte, one of these nuclei functioning as an egg nucleus. This is the most reduced condition yet described for an angiosperm. We have found, quite recently, in *Cypripedium*, a mature female gametophyte containing only four nuclei. The antipodal polar nucleus had not divided and was disintegrating. One mitosis in the micropylar end had also failed to take place. One might reasonably hope to find still greater reduction in the tropical orchids, so that while the stage shown in Fig. 2, *I*, is still hypothetical, it is not at all impossible that it may exist. The megaspore would then function directly as an egg and the four spores would correspond strictly with the egg and the three polar bodies.

The series, as a whole, shows a gradual reduction of the gametophyte from an independent plant to a parasite; then a reduction from a cellular condition to the free nuclear condition; and finally a reduction in the number of free nuclei, until (admitting the hypothetical case shown in Fig. 2, *I*) the condition shown by the animal egg with its three polar bodies is reached. The behavior of the chromosomes during the formation of the four megaspores is essentially identical with their behavior during the formation of the egg and its polar bodies.

It was only by the investigation of forms below the angiosperms that the true nature of the female gametophyte of angiosperms became known. Perhaps a more thorough examination of animals below the Metazoa may aid in interpreting the egg and its polar bodies.

Since there would be much repetition in a discussion of the male gametophyte, this subject is omitted.

I regret that Professor Beard's work was overlooked. In this one particular Professor Lyon's criticism must be accepted. The fact, however, that Professor Beard relies strongly upon apogamy to support his theory will indicate to botanists a view-point somewhat different from mine.

It is gratifying to note that Dr. Lotsy's[8] recent paper on the x and $2x$ generations is directly in line with my theory.

CHARLES J. CHAMBERLAIN.

PRELIMINARY NOTE ON A GIGANTIC MAMMAL FROM THE LOUP FORK BEDS OF NEBRASKA.

DURING the summer of 1904 the writer was fortunate in locating an important fossil quarry in the upper series of the Loup Fork formation on the Niobrara River, four miles east of Agate P. O., Sioux County, Nebr., upon the property of Mr. James H. Cook, the Agate Springs Stock Farm. The existence of fossil bones in this locality was known to Mr. Cook as long ago as the year 1890, but he regarded the fragments of bones, when he first found them, as merely proving that the spot had been occupied by the Indians as a burying ground, they having frequented the locality in early days and frequently camped there. In August, 1904, I was guided to the spot by Mr. Cook's son, Harold J. Cook, and made some preliminary investigation. The work has been continued throughout the spring and summer of the current year under my direction. An interesting feature of the deposit is the great number of water-worn fragments of bone found in the quarry, clearly indicating that the remains were subjected to the action of a

[8] Lotsy, J. P., 'Die x-Generation und die $2x$-Generation, eine Arbeitshypothese,' *Biol. Centralblatt*, **25**: 97–117, four text diagrams, 1905.

current of water, or perhaps to the action of waves beating upon the shore of a lake. The latter seems the more probable hypothesis.

Family SUIDÆ.

DINOCHŒRUS HOLLANDI[1] gen. et sp. nov.

This new genus and species was recently exhumed in the Agate Springs Fossil Quarry by T. F. Olcott, a member of the Carnegie Museum field party in this region. The type consists of the greater portion of the skeleton of, perhaps, one of the most striking animals found thus far in this quarry. The animal is closely related to the genus *Elotherium* found in the Oligocene formation. The dentition is apparently somewhat more specialized than in the latter genus. There is only a faint trace of the cingulum on the inferior premolars. This cingulum terminates on the posterior base of the tooth, forming a rather heavy basal heel. There is no cingulum on the inferior molars. The dentition on the whole is characteristically similar to that of *Elotherium*, as is also the general contour of the skull. The limbs are elongated, and the general structure of the skeleton recalls that of the Oligocene genus. This similarity is of much interest when the changes which have taken place since the Oligocene time in the Oreodontidæ and the Camelidæ are considered. The gigantic size of this Loup Fork species (the length of the cranium alone being about 90 cm.), together with the fact that the remains are found in a much later geological horizon than that in which *Elotherium* has been found, is thought by the writer to be of sufficient importance, pending a more thorough study of the type, to provisionally separate the two forms generically.

When the material is cleared up a final study of the osteology of the specimen will be made and a detailed description will appear in the publications of the Carnegie Museum.

O. A. PETERSON.

CARNEGIE MUSEUM,
July 31, 1905.

[1] The specific name is given in honor of Dr. W. J. Holland, the Director and Acting Curator of Paleontology in the Carnegie Museum.

QUOTATIONS.

THE DEPARTMENT OF AGRICULTURE.

FURTHER investigation has brought to light in the Department of Agriculture additional transactions that have excited some criticism. The grand jury at Washington is still at work upon the offenses of Assistant Statistician Holmes. Chief Statistician John Hyde, who resigned and at once sailed for Europe, has been asked by Secretary Wilson to come back. He replies that he will return without delay. He is wanted as a witness before the grand jury. After a long conference with the President last week Attorney-General Moody said that the Federal criminal statutes were so antiquated that they did not meet existing conditions. Congress will be asked to make them broader and more stringent. President Jordan, of the Southern Cotton Association, demands the removal of the secretary, asserting that he is incompetent. The secretary, in whom Mr. Roosevelt has confidence, says it would be cowardly for him to resign while his department is under fire. Investigation is being made as to the connection of several prominent officers of the geological survey, as directors and stockholders, with a journal devoted to mining. It is asserted that much information obtained at the expense of the government has been published by them in that journal long before the appearance of it in the official reports, which, it is said, have been unwarrantably delayed. It is asserted in similar charges against the Fish Bureau that much information has been published in magazines by officers, with illustrations, prepared by the government, which have appeared in the official reports several months later. Dr. D. E. Salmon, the well-known head of the Bureau of Animal Industry, is criticized by some because of his association with the contractor who supplies labels (invented by himself) for use in the inspection of meat. It appears that Dr. Salmon assisted this man some years ago and was his partner for six years in a small printing business. At Dr. Salmon's suggestion he invented the label, but Dr. Salmon withdrew from the partnership very soon after the inventor obtained his first contract, in 1901, and has

since had no financial interest in the business. The inventor has been quite successful. Many millions of the labels are used by the government. At present he is at the head of a business capitalized at $500,000. Having elicited these facts, Secretary Wilson was inclined to discontinue the investigation of this case, but at the direction of the President further inquiries are to be made. It appears that Dr. Moore (who recently resigned) could have made himself rich by a commercial use of his discovery of a bacterial culture for the inoculation of soil. He took out patents, but gave the free use of the discovery to the people of the United States. Some say that he could have become a millionaire by the sale of it here and abroad. His resignation was due to public criticism of his conditional negotiations, terminated some time ago, with a company engaged in the manufacture of the bacterial culture which he invented. The Weather Bureau has been attacked by persons who asserted that $60,000 was spent in erecting in the mountains of Virginia buildings which served as a kind of summer resort for the officers. Investigation, so far as it has proceeded, indicates that there was no just warrant for such a charge. Independent slaughterers and beef packers have complained that they suffered in competiti with the trust because they could obtain no government inspection of their products. Dr. Salmon's answer to this is that the export trade, which is controlled by the trust, must be subjected to inspection; that the appropriations are not sufficient to provide for the inspection of meats for domestic consumption, and that the house committee on agriculture has warned the department not to extend its inspection to the concerns engaged exclusively in the domestic trade.—*The Independent.*

THE PROPOSED ALLIANCE BETWEEN THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY AND HARVARD UNIVERSITY.[1]

THE corporation naturally reserved to itself the right to pass upon the financial aspects of the proposed arrangement. For giving a decision on this point the members are fitted by training and occupation, as a recital of the positions held by them would show. Since, however, they are almost all unfamiliar with educational problems, and since they regarded the alliance with Harvard as fundamentally an educational measure, as the testimony just quoted plainly shows, they very properly referred this 'proposed agreement' to their own body of educational experts, the faculty, and to those other parties in interest, the alumni, who, while not expert in matters of education, are, nevertheless, familiar with the institute system of education, and by their professional experience have given it the only conclusive test.

Upon receiving this invitation of the corporation, the faculty, who, at the request of the president, had studiously refrained from taking any earlier action upon the question, seriously discussed and considered the problem, upon its educational side, in a protracted series of meetings, and presented their collective opinion (there being but seven dissenting voices, including that of the president, in a membership of sixty-five) in a temperate and reasoned report. The executive committee of the alumni association, also made every exertion to have both sides of the question presented fully and fairly to the alumni, which body deliberately expressed itself as opposed to the proposed agreement. In view of the corporation's subsequent vote and the failure of that body to attempt to conciliate the opposing views by suggesting any modification of the proposed agreement or even by stating its reasons for disagreeing with those views, the alumni may properly inquire why they should have been encouraged to believe their opinion to be really wanted. The faculty may well ask why they should have been put to so much trouble if their judgment, as experienced teachers, upon a question declared to be fundamentally educational, was, after all, to receive so little respect. The faculty had every moral right, they had every right in equity, not only to be heard, but to be heeded. Moreover, if, as the president declares, 'the fame of the institute rests upon the work and reputation of the alumni,' those alumni should cer-

[1] Concluding part of an editorial in *The Technology Review.*

tainly share with the corporation the right of deciding the future of the school. The president, who in words asserted, and the majority of the corporation present at the meeting, who by their votes declared that it was justifiable to disregard the opinion of nine tenths of the faculty and of three fourths of the graduates, could scarcely have realized how extraordinary and grave an exercise of corporate power, far-reaching in its effect upon education, their action involved. In giving no heed to the opinions of the two coordinate bodies who have done most to create the reputation of the institute, the corporation took the stand that its legal authority justified it in regarding its own judgment as superior to that of men more familiar with the conditions of successful technological education. What is of even greater consequence, this action of theirs imperils all higher education; for, by thus ignoring the solicited opinions of their faculty, they reduce that body to the level of mere hirelings, and, by contravening the wishes of the alumni, they affront that graduate loyalty which is the vital principle of every efficient college.

The charter of the institute created a corporation of fifty men, including, *ex officiis,* the governor, the chief justice of the supreme court, and the secretary of the board of education. With the exception of these three, the body is self-perpetuating, and is responsible only to the commonwealth. This self-elective body has included many of the most distinguished men of Massachusetts, and of these not a few have given much time and thought to the building up of the institute and to the management of its funds and property. Many of them, too, have contributed liberally to its funds, and have induced gifts and bequests from others. Nevertheless, no one would for a moment assert that the corporation has been the chief factor in making the high reputation or in guiding the successful policy of the institute of technology. That policy has been shaped almost wholly by the faculty, whose educational prerogatives have in the past been cordially supported by the president and corporation of the institute; that reputation has been given by the teaching of the faculty and by the professional and personal achievements of the five or six thousand past students. In short, the institute, like every other college of English origin, has not been in the main the educational creation, and is not the educational property of its legal trustees. On the contrary, it has been built up by, and should be in the keeping of, three bodies, or 'estates': the corporation, who guard its financial and legal interests; the faculty, who determine its educational policy; and the alumni, who, by the success of their professional careers and by their direct efforts, secure for it the support of the community. What the faculty have done no one familiar with education and applied science needs to be told. What the past students have done professionally is shown by the honorable record in the 'Register of Graduates'; what they are ready to do financially is made evident by the William Barton Rogers Fund, the Walker Memorial Fund, and the Technology Fund.

In any rational system of government there should be the closest and most cordial cooperation between these three bodies—a cooperation that might, perhaps, best be attained through a joint advisory council of the corporation and faculty, with the president as its chairman, and through direct representation of the alumni upon the corporation and its executive committee. In the absence of any provision for such formal cooperation, the legal trustees were under a strong moral obligation to recognize this triple control and responsibility, and to take no final action of importance until a reasonable degree of harmony and agreement as to the step contemplated had been secured. Yet, when there arose the gravest of questions—one affecting the autonomy and possibly the continued life of the institute—they ignored that coordinate responsibility and acted in opposition to the expressed wishes of those most vitally concerned. This is an exercise of legal power, as opposed to moral responsibility, momentous in its consequences.

Attempt has been made to excuse the ignoring of the faculty's opinion, on the ground that that body is too near the problem to judge it without prejudice; but is the corporation itself likely to be thought more free from

bias when it is considered that at least fourteen out of the twenty-three members who voted for the 'proposed agreement' are alumni of, or are otherwise closely affiliated with, Harvard University, and that three out of the four conferees who drew up the agreement are officially connected with that university? Is it maintained that devotion to the institute blinds the faculty (nearly half made up of men who are not technology graduates), while zeal for Harvard does not blind members of the corporation to the true interests of the institute and of education?

The alumni vote was disregarded, it has been stated, because it was not more complete. That it was not larger is due, in great part, to the fact that, pressed on the one hand by the need of waiting for the opinion of the faculty, and, on the other, by the request of the corporation that the vote be in not later than June 1, the executive committee could give the alumni only ten days in which to receive and digest the great mass of argument sent to them, and to get their ballots into the hands of the committee. Most of the members of the corporation, however, have long been associated with many large voting bodies and must be fully aware, not only of the difficulty of securing a full vote from a widely scattered body of three thousand busy men, but also of the general experience that the ratio of voting, after the first few hundred ballots come in, remains almost constant, and that, therefore, had every alumnus registered his opinion, the final proportion (three opposed to one in favor of the plan) would have been almost exactly the same.[2]

Taking into consideration, therefore, the three coordinate bodies which, in equity if not in law, govern the Institute of Technology, the registered vote upon the 'proposed agreement' stands, numerically, 1,422 against the plan to 488 in its favor; and the vote by percentages is as follows:

	Against the Agreement.	For the Agreement.
Corporation	40 per cent.	60 per cent.
Faculty	89 per cent.	11 per cent.
Graduates	75 per cent.	25 per cent.

If the plan is presented to Harvard, therefore, it goes with the indorsement of only one fourth of the men in those three bodies which have made the institute what it is and upon which the school must depend for future strength and usefulness. Is it likely, then, that there can be a genuine and hearty 'combination of effort' with Harvard University, especially in view of the well-known opposition to the alliance of practically all the Lawrence Scientific School faculty and alumni, of many, if not most of the academic faculty of Harvard, and of the close friends, including the chairman of the trustees, of Mr. McKay? A partnership between Harvard and the institute to which substantially all the parties in interest consented might be practicable; but one like this, which is repugnant to most of those whose good will and enthusiastic efforts are essential, must inevitably result, if attempt is made to force it through, not only in the wrecking of the institute, but also in the controlling of education by purely business standards. To use the methods of industrial trusts in conducting colleges and universities is to threaten the present efficiency and ultimately the life of all higher education.

[2] Significant in this connection are the votes of the last two classes, who are most intimate with the institute as it is, and who have been directly under the influence of the alliance discussion. At the time of its graduation, a year ago, the class of 1904 was overwhelmingly in favor of an alliance. Their recent official votes against the 'proposed agreement,' however, was 116 to 22. No vote was requested from the class of 1905, but the poll which they took themselves stands in the ratio of 95 to 5 against the proposed alliance.

MATHEMATICS IN JAPAN.

AT the celebration of the last birthday of the emperor of Germany Professor Harzer delivered a long address on the 'Exact Sciences in Old Japan.'[1] Although Professor Harzer is an astronomer, he devoted nearly his entire address to the history of mathematics, saying that 'the little that is known of Japanese astronomy does not awaken any hope of any achievements worth mentioning

[1] *Jahresbericht der Deutschen Mathematiker-Vereinigung*, Vol. 14, 1905, pp. 312–339.

along this line.' Even in mathematics too little of the available material has been critically examined to make it possible to write a complete and trustworthy history, but the sudden prominence of Japanese activity and power gives unusual interest to any facts relating to the thought and scientific development of this country.

The 2,000 mathematical works in the royal library of Tokio, some of which date back to 1595, are a sufficient guarantee of high esteem for mathematical knowledge. As the Japanese mind is very practical and shows little aptitude for the abstract and philosophical, it is to be expected that their mathematical achievements are in very close touch with practical problems and are foreign to those fields of mathematics which border on philosophy. The determination of the area of the circle in terms of its diameter is one of the most important of these practical problems and the Japanese took especial interest in developments which were useful to obtain an approximate solution of this problem.

Such a solution is equivalent to an approximate determination of the ratio between the diameter and the circumference of a circle. This ratio, known as the Ludolphian number, plays such a prominent rôle in the development of mathematics that so eminent a mathematician as Glaisher has remarked that its history is almost identical with the history of mathematics. The approximate value of this number can be most readily obtained by infinite series, and this is the method which the Japanese employed as early as the seventeenth century. In doing this they used the binomial theorem for fractional exponents as early if not earlier than Newton did. One of the proudest triumphs of this master mind was, therefore, achieved independently by the race whose recent marvelous progress has been attracting universal attention.

One of the other prominent discoveries of Newton, viz., the infinitesimal calculus, seems also to have been discovered independently by the Japanese, although the evidence on this point is not conclusive. It is, however, certain that the Japanese were not far behind the Europeans in their mathematical attainments during the latter part of the seventeenth century. Since then they have not made the rapid progress which Europe has witnessed as a result of the work of Euler, Lagrange, Cauchy and Gauss. They did not have any such leaders, and hence their advanced mathematics was practically neglected.

Within recent years there has been a great advance in mathematical instruction. A large number of students are debarred from the upper classes of the higher institutions on account of their lack in mathematical training. There seems to be a very widespread feeling that the educational system is mostly in need of improvement along the line of mathematical instruction and the efforts towards progress along this line exhibit Japanese vigor and courage. It will probably require a number of years before much will be accomplished in higher mathematics.

The most surprising fact about Japanese mathematics is that, while the most elementary parts were regarded as common property, the more advanced results were regarded as secrets which should be communicated to a very few. In fact, an oath of secrecy was required of those who wished to hear lectures on advanced mathematics. European history furnishes a parallel to this in the Pythagorean school, but it is so totally different from the modern spirit that its existence 2,000 years after Pythagoras was unexpected. Fortunately all this has recently changed to such an extent that a history of Japanese mathematics could be published a few years ago. A small part of this has been translated into English.[2]

G. A. MILLER.

STANFORD UNIVERSITY.

PROPOSED MAGNETIC AND ALLIED OBSERVATIONS DURING THE TOTAL SOLAR ECLIPSE, AUGUST 30, 1905.

IN response to my appeal for simultaneous magnetic and allied observations during the coming total solar eclipse, cooperative work

[2] Tsuruichi Hayashi, 'A Brief History of the Japanese Mathematics,' *Nieuw Archief voor wiskunde*, 1904, pp. 296–324; 1905, pp. 325–361.

will be conducted at stations distributed practically along the entire belt of totality and also at outside stations, nearly every civilized nation participating.

These observations will afford a splendid opportunity for further testing the result already obtained. All those who are able to cooperate are invited to participate in this important work.

The scheme of work proposed embraces the following:

1. Simultaneous magnetic observations of any or all of the elements according to instruments at the observer's disposal, every minute from August 29, 22 h., to August 30, 4 h., Greenwich mean, astronomical time.

[To insure the highest degree of accuracy attainable, the observer should begin work early enough to have everything in complete readiness in proper time. See precautions taken in previous eclipse work as explained in *Terrestrial Magnetism*, Vol. V., page 146, and Vol. VII., page 16. *It is essential, as shown by past experience, that the same observer make the readings throughout the entire interval.*]

2. At magnetic observatories, all necessary precautions should be taken so that the self-recording instruments will be in good operation not only during the proposed interval, but also for some time before and after, and eye readings should be taken in addition wherever it be convenient.

[*It is recommended that, in general, the magnetograph be run on the usual speed throughout the interval, and that, if a change in the recording speed be made, every precaution possible be taken to guard against instrumental changes likely to affect the continuity of the base line.*]

3. Atmospheric electricity observations should be made to the extent possible by the observer's equipment and personnel at his disposal.

4. Meteorological observations in accordance with the observer's equipment should be made at convenient periods (as short as possible) throughout the interval. It is suggested that, at least, temperatures be read every fifth minute (directly after the magnetic reading for that minute).

5. Observers in the belt of totality are requested to take the magnetic reading every fifteen seconds during the time of totality and to read temperatures as frequently as possible.

6. At those stations where the normal diurnal variation can not be obtained from self-recording instruments, it is desirable to make the necessary observations for this purpose on as many days as possible before and after the day of the eclipse, and to extend, if possible, the above interval of observation. In general, those who will have self-recording instruments have decided to run them for at least eight days before and after the day of the eclipse.

It is hoped that observers will send full reports of their work to me as soon as possible for incorporation in the complete monograph on this subject to be published by the Carnegie Institution of Washington.

L. A. Bauer.

Dept. Terrestrial Magnetism,
Carnegie Institution,
Washington, D. C.,
July 15, 1905.

NOMENCLATURE AT THE VIENNA INTERNATIONAL BOTANICAL CONGRESS.

An international botanical congress was held at Vienna, Austria, June 11–18, 1905, under the presidency of Professor Julius Wiesner, of the University of Vienna, and a number of vice-presidents selected from the delegates from various countries. Between five hundred and six hundred persons were in attendance. After addresses of welcome by scientific and governmental Austrian officials, the congress divided into two sections, holding sessions, (1) for the general business of the congress and the reading of scientific papers, and (2) for the discussion of the special subject of botanical nomenclature, which had been arranged in advance on the basis of a vote by members of an international commission, appointed at the botanical congress held at Paris in 1900. The procedure had been capitally organized by Professor John Briquet, director of the botanical garden of Geneva, and reporter general of the

international commission; he had compiled, translated into French, and arranged for comparison all the numerous propositions relative to plant nomenclature published since the congress held in Paris in 1867, including the laws of nomenclature adopted by that body, and the general features of the code of botanical nomenclature adopted at the International Zoological Congress held at Berlin in August, 1901; this great work entailed the study of over forty printed documents, many of them of considerable length. Dr. Briquet's compilation was published under the auspices of a bureau established by the Paris congress of 1900 and by the local committee of the Vienna congress of 1905, under the title 'Texte Synoptique des Documents destinés a servir de base aux débats du Congrès International de Nomenclature Botanique de Vienne 1905,' a quarto book of 160 pages. This was distributed to the members of the international commission for their preliminary yes or no votes on the numerous and widely differing propositions, late in December, 1904, with the requirement that the votes must be received by the reporter general at Geneva not later than January 20, 1905; this requirement allowed very little time for members of the commission distant from Europe to consider the relative value of the propositions as presented by Dr. Briquet, a copy reaching New York only on January 18; thus no votes were included of members of the commission resident in South America, Asia or Australasia, and from only two of the four members each from Russia and the United States. For this reason, and for others, only 31 members voted out of the 47 appointed at Paris in 1900, and of these, 15 were German, Austrian, Belgian or Swiss.

Using the vote thus obtained as a basis, Dr. Briquet formulated a series of rules and recommendations for debate at Vienna, omitting in this, however, any cases in which he could not fairly figure out a majority of the 31 commissioners voting. The rules and recommendations thus obtained, were printed in a column reserved for them in the pages of the 'Texte Synoptique,' which had meanwhile been held in type, together with remarks and observations of the reporter general in another column similarly reserved; the document, thus increased, was again transmitted to the members of the international congress, as well as to all delegates from institutions and societies accredited to take part in the nomenclature debate at Vienna of 1905 under the conditions prescribed at the Paris congress of 1900, and these rules and recommendations thus submitted became the actual topics of debate at Vienna, little attention being paid there to any other propositions. I have described the preliminaries of the method of reaching the votes actually cast at Vienna in this detail as a matter of general interest; it will at once be seen that the method was well calculated to bring out opinions, and 31 out of 47 votes in the international commission was in a measure successful; no attempt was made, however, to hold a meeting of the international commission in advance of the congress to aid the reporter general in framing the rules and recommendations for discussion, and thus no opportunity for any preliminary agreement was provided.

The section of the Vienna congress which occupied itself with the discussion of the rules and recommendations thus enunciated, held its sessions every afternoon of the congress week in the lecture hall of the university botanical garden, under the able presidency of Professor Flahault of Montpellier, assisted by Professor Mez of Halle and Mr. Rendle of the British Museum of Natural History as vice-presidents; Dr. Briquet acted as the mentor of the meetings, doing much of the translation required and recapitulating the discussions in advance of the vote; there were three secretaries representing the French, English and German languages; the official language was French. The conditions prescribed for the voting on motions and propositions enabled a delegate to vote on behalf of a number of societies or institutions, if he was properly accredited by them to the congress; the number of delegates present was about 75, casting nearly 200 votes; of these

votes more than a majority came from Germany, Austria, Switzerland and Belgium; only two English delegates attended and the Royal Gardens at Kew were not represented in the voting; twelve delegates were present from the United States, casting about 30 votes. The actual voting was by means of printed ballots, except in the case of propositions which developed no debate, which were adopted *viva voce.*

Dr. Otto Kuntze, whose writings on the subject of botanical nomenclature have been the most voluminous, was not a delegate, nor were his views represented, inasmuch as he regards the appointment of the international commission at Paris as irregular, the preponderating vote of the central European countries as unfair, and the whole congress as incompetent to reach an international result. He appeared before one of the meetings and read a protest, distributing at the same time a printed document in support of his contentions. No opportunity for work by committees was permitted by the controlling vote, one subject only being permitted to go to conference, and on this one unanimity was reached; attempts were made to reopen several propositions supported by a large minority, in the hope that mutual concessions would lead to further unanimity, but the majority refused to permit this course to be taken; no attempt whatever was made to approach zoological usage.

The details of the rules and recommendations approved by the congress must await the publication of the official reports; meanwhile, the following general results may be mentioned:

1. Consideration of the nomenclature of the cellular cryptogams (Thallophytes and Bryophytes) was referred to a commission to report to the next international congress, to be held in Brussels in 1910.

2. The nomenclature of fossil plants was referred to another commission to report at the same time.

3. The congress was nearly unanimously in favor of establishing the date of departure for the names of both genera and species with the publication of Linnæus' 'Species Plantarum,' 1753.

4. Uniform terminations for orders, families, tribes and other ranks, were unanimously agreed upon.

5. The stability of the specific name, when the species is transferred from one genus to another, was essentially unanimously approved, only two votes being cast against it, but when the rank is changed the preservation of the name was not made necessary; the only exception to this general rule was made in the case of double names, such as *Linaria linaria,* the vote being 116 to 72.

6. The congress approved a method of determining the generic name when an old genus is divided, essentially as it was laid down at the Paris congress of 1867, no advance being made on this line, and no provision being made for the establishment of generic types, although the vote on this question was 106 to 74.

7. Although having adopted unanimously as a leading article, a principle to the effect that the rules of nomenclature must not be arbitrary, the congress by a large majority voted to approve the exception of more than 400 generic names from the operation of all nomenclatorial rules, a list of such names submitted by Herr Harms of Berlin being adopted; the congress thus went on record as not regarding priority as a very important general principle. It was also maintained that other names may be added to this list in the future.

8. The congress approved, by a vote of 105 to 88, the requirement that after January 1, 1908, in order to constitute valid publication, a new name must be accompanied by a diagnosis in Latin, this not applying, however, to works already in course of publication.

9. The congress voted against the principle of the rejection of all homonyms better known to zoologists as the principle of 'once a synonym always a synonym,' thus failing to recognize this as an important aid in securing the stability of names.

10. The metric measurements were strongly recommended by a unanimous vote.

N. L. BRITTON.

SCIENTIFIC NOTES AND NEWS.

The official party of the British Asociation, including Professor G. H. Darwin, the president, and the other officers, left Southampton by the mail steamer *Saxon* on July 29 for Cape Town, where they were expected to arrive on the fifteenth inst. The party included Professor Ernest W. Brown, of Haverford College; Professor Henry S. Carhart, of the University of Michigan; Professor W. M. Davis, of Harvard University, and Professor William B. Scott, of Princeton University.

Major Ronald Ross, professor of tropical medicine, and Dr. Rupert W. Boyce, professor of pathology and dean of the School of Tropical Medicine, Liverpool, sailed on August 12 on the *Campania* for New York, *en route* to New Orleans, where they will study the epidemic of yellow fever.

The Observatory gives the following information in regard to eclipse expeditions: The astronomer royal and Mr. Dyson, with Professor Sampson, have started for Sfax. Professor Turner and Mr. Bellamy have left for Egypt. Sir Norman and Dr. Lockyer with their party intended to have anchored the gunboat which is put at their disposal in the harbor of Philippeville, in Algeria, but for certain reasons the French object. Several French observing-parties are arranged: MM. Deslandres and Rayet will be at Burgos; M. André, of the Lyons Observatory, at Tortosa; M. Trépied, of Algiers, with MM. Stephan and Borelly, of Marseilles, are going to Guelma, where there will be some observers from Paris; M. Bigourdan, of the Paris Observatory, proposes to make actinometric observations at Sfax, and there will also be a French expedition to Cistierna, in Leon. The Peninsular and Oriental Company is arranging to send a vessel by way of Gibraltar to Palma, where she will wait during the eclipse, and thence to Marseilles.

Dr. Stewart Paton, formerly of the Johns Hopkins University, who recently occupied the Smithsonian table at the Naples Zoological Station for a term of three weeks, has received an appointment to that Station for six months from November 1, 1905. Dr. Harold Heath, associate professor of zoology in the Leland Stanford Junior University, has been awarded the Smithsonian table at the station for three months from January 15, 1906.

An expedition to Florida for the purpose of securing series of the embryos of the alligator has recently been conducted for the Smithsonian Institution by Professor Albert M. Reese, of Syracuse University. Professor Reese reports almost complete success, he having already obtained a fine series of nearly three hundred embryos, covering all but the very earliest stages of development.

During the month of July Messrs. M. L. Fuller and F. G. Clapp, of the U. S. Geological Survey, made a reconnaissance trip through Newfoundland and along the coast of Labrador to a point north of Hopedale for the purpose of comparing the glacial features with those of northeastern United States. Several interesting points relating to possible Pre-Wisconsin deposits, to the origin of the high terraces and to the recentness of the last glaciation were brought out. The intention was to go further north, but this was impossible because of the presence of unusually heavy pack ice along the shore from which the vessel was obliged to withdraw after penetrating it for a distance of some ten miles.

Dr. Ernst Ebermayer, professor of agriculture in the University of Munich, celebrated on July 3 the fiftieth anniversary of his doctorate.

Mr. A. B. Skinner has been appointed director of the South Kensington Museum, succeeding Sir Caspar Purdon Clarke, the new director of the Metropolitan Museum of Art, New York City.

Mr. W. A. Davie, assistant lecturer in agricultural chemistry, Aberdeen University, has been appointed a deputy-inspector in the Agriculture and Lands Department under the Soudan Government.

Mr. J. R. McColl, associate professor of steam engineering at Purdue University, has accepted a position in the engineering department of the American Blower Co., at Detroit.

PROFESSOR VOSSIUS, rector of the University of Giessen, gave an address at the recent celebration of the university on 'The recent development of ophthalmology.'

THE Alvarenga Prize of the College of Physicians of Philadelphia has been awarded to Dr. Chalmers Watson, Edinburgh, for an essay on 'The Importance of Diet; an Experimental Study from a New Standpoint.'

A STATUE in honor of Robert Bunsen, the eminent chemist, is to be erected in Heidelberg.

PROFESSOR ALEXANDER MELVILLE BELL died on August 7, at the age of eighty-six years. Professor Bell was known for his important contributions to phonetics. Like his father, Alexander Bell, formerly professor of elocution in London, and his son, Dr. A. Graham Bell, he took an important part in developing modern methods of teaching the deaf and dumb.

GENERAL ROYCE STONE, the well-known army officer and engineer, died on August 5, at the age of sixty-nine years.

THE death at the age of forty-six years, of Mr. H. Lamb, of Maidstone, author of 'The Flora of Maidstone,' is reported in *Nature*.

THE International Anatomical Congress, which has been in session in Geneva during the past week, has accepted an invitation to meet in Boston in 1906.

THE arctic steamer *Terra Nova*, which went to the relief of the Ziegler polar expedition, has rescued Capt. Fiala and all the others connected with the expedition. Mr. W. J. Peters, of the U. S. Geological Survey, who, on the nomination of the National Geographic Society, was placed in charge of the scientific work of the expedition, has cabled that a considerable amount of scientific work has been accomplished.

THE next award of the Rogers prize will be made by London University in 1907. The subject announced is 'The Physiology and Pathology of the Pancreas.'

THE Carnegie Museum of Pittsburg has acquired by purchase the entire collection of the birds of New Zealand belonging to Sir Walter L. Buller, K.C.M.G., F.R.S., upon which he founded his magnificent standard work upon the birds of New Zealand. The collection contains a number of species in all stages which are now known to be extinct or rapidly verging upon extinction. Gould's birds of Australia are the property of the Academy of Natural Sciences in Philadelphia. It is rather remarkable that the two great classic collections of birds from the antipodes should both have found a final resting place upon the soil of Pennsylvania.

DR. A. PECKOVER has presented to the Royal Geographical Society, of which he has been a fellow since 1853, a valuable collection of atlases and maps.

THE demand for foresters is increasing rapidly both for state work and with private owners. Many states now have forest commissions, and several of them have state foresters. A trained forester at $2,400 a year and two assistant foresters at $1,200 each are wanted by California. Wisconsin wants an assistant forester at $1,500, Indiana a forester to take charge of its state reserve, and Washington offers $1,800 a year for a trained forester. In many other states the advisability of creating the office of state forester has been under discussion this year, and it is only a matter of a few years when such an official will be considered a regular part of an efficient state government. The demand for foresters by private timber owners is growing at a still more rapid rate. During the last twelve months seven of the Bureau of Forestry force have left to take up work with such owners, and four have accepted public positions—two with Massachusetts, one with Connecticut, and the fourth with Ontario, Canada. A number of other requests from private owners can not be met because men are not available. The year before there were less than half as many applications for trained men. But the demand for trained specialists in this line has only begun. Large lumber companies, great wood manufacturing concerns, owners of extensive forests, railroad companies and others are taking a hitherto unknown practical interest in

conservative forestry. They must have expert men to control their holdings. The result is that forestry is very rapidly taking its place as a recognized profession. A number of forest schools are training young men for this work, but the demand has outrun the supply.

We learn from the London *Times* that a conference was held in London, on June 22, between representatives of sea fishery authorities and the board of agriculture and fisheries on matters affecting the sea-fishing industry of the United Kingdom. Mr. Ailwyn Fellowes, M.P., in welcoming the delegates from the sea fisheries committees, regretted that much had not resulted from their conferences in the past in the way of legislation; but he hoped that now that the fisheries had been taken from an overburdened department like the board of trade to the board of agriculture something would be done for the fishing industry. Many of the matters in which they asked for legislation required money; but, unfortunately, the imperial finances were not in such a satisfactory state as to allow of money being spent at present on sea fisheries. He hoped that in future there would be more frequent meetings of the officials of the board of agriculture and fisheries and the representatives of the sea fisheries districts in dealing with local fishery problems, and also in promoting legislation applicable to the whole kingdom. The conference then proceeded to discuss several subjects, such as the protection of undersized sea fish and lobsters, fishery statistics, the pollution of estuaries and inspection of shell-fish beds, and the necessity of imperial grants being given to local fisheries committees for fishery research. At the conclusion of the conference Sir Thomas Elliott said it was the desire of the board to further in every way the sea-fishing industry of the country.

The *Geographical Journal* states that the latest report to the Academy of Sciences, by the French committee controlling the scientific operations for the degree measurement in Ecuador shows that the difficulties with which the observers have had to contend have shown no signs of lessening during the year under review, and that, as a result, the completion of the undertaking must once again be subject to an unforeseen delay. As in former years, the meteorological conditions have proved persistently adverse, the amount of fog prevailing in the upper region of the Andes rendering long sojourns at many of the stations necessary. Besides this, the presence of bubonic plague in Ecuador has further hampered operations, while several of the officers in charge have been invalided through fever and other illnesses. After summarizing the operations actually carried out in 1904, the report discusses the steps to be taken in view of the unexpected retardation of the work. In order to keep within the limits of the funds at present available, it would be necessary to curtail the operations in four different ways, *viz.*, by shortening the length of the arc; substituting a less precise method for the measurement of the southern base; omitting the pendulum observations; and giving up the extension to Machala on the coast. The reporter points out the grave defects by which the results would be impaired if these curtailments of the original plan were decided on, one important requirement—viz. the testing of the possible effect on the form of the geoid exercised by the attraction of the Andes—being thereby left unfulfilled. It is therefore urged that the idea of such an abbreviation should not be entertained, but that every effort should be made to carry out the undertaking in its entirety. It is thought that, even allowing for continued causes of delay, the whole should be completed by May, 1906.

Counsel Bardel, writing from Bamberg, Germany, says that in order to promote agricultural interests the Kingdom of Bavaria has established agricultural schools in thirty-one towns. These schools are in charge of teachers who, in addition to an academical education, must be generally efficient in botany, geology, chemistry, physics, zoology and natural history. The consul says: At a time when nothing is doing in the fields, from November to March, these schools are open, and peasant farmers for a nominal fee can attend courses on cultivation and fertilization of the soil, the

proper succession of crops on the same land, the best sources for good seeds, irrigation, and the raising of stock. They are made acquainted with improvements and new inventions in agricultural implements the adoption of which can be recommended. They are taught the rudiments of bookkeeping and other commercial knowledge essential for the up-to-date farmer. In the spring, after these farmers have returned to their work in the fields, it becomes the duty of the teachers who instructed them during the winter to travel from county to county and to act as advisers to the farmers. Much good results from the travels of these wandering teachers. By practical suggestions to the farmers they induce them to make valuable improvements in the cultivation of their farms. The wandering teacher helps to form cooperative clubs for the joint interests of a number of farmers in one district. From time to time the teacher has to lecture in these clubs on any subject practical or scientific which might prove of interest to the members. These visits and lectures to the different districts are entirely free to the people, since the state assumes all expenses. There is probably no other country in the world in which so much is done by the state for its rural inhabitants as is the case in Bavaria. Other German states have these agricultural schools, but their teachers are not sent in such a practical way direct to the places where they can do the most good, as is done here. The results of this commendable care have been very gratifying.

Concerning the exhibition held recently in London in connection with the Optical Congress, *Nature* says: The exhibition of optical and scientific instruments which is being held during the present week at the Northampton Institute, Clerkenwell, E.C., in connection with the optical convention, presents many features of interest, and all who have had any experience in the use of an optical instrument, from the wearing of a pair of spectacles to the handling of an accurate spectrometer, will find something to repay the trouble of a visit to Clerkenwell, still the center of the optical industry. While the number of actual novelties offered is not, perhaps, very large, there are few classes of instruments unrepresented, and though the names of certain important firms are conspicuously absent from the list of exhibitors, the exhibition as a whole may be taken as well representative of the activities of the British manufacturers of optical and other scientific instruments. In the main of an optical character, the scope of the exhibition has been extended to cover such other scientific instruments as are usually manufactured by optical instrument makers. Meteorological instruments and thermometers, mathematical and drawing instruments and calculating machines, and laboratory apparatus generally, are thus included. Electrical measuring instruments, however, are not shown. It is for many reasons to be regretted that the exhibition has been confined to the work of British makers; a foreign section would have had much interest for the ordinary visitor, and would have been of great educational value both to the British manufacturer and his competitors; we understand, however, that the limitation was dictated by considerations as to space, and the necessity of restricting the magnitude of a somewhat novel undertaking. In the catalogue which has been prepared in connection with the exhibition, the convention committee is to be congratulated on having produced a volume which should be of considerable value as well to the user of scientific instruments as to the firms whose instruments are there described. The volume is not confined to apparatus actually exhibited; the aim has been to provide a convenient work of reference generally descriptive of the productions of British firms, and in which particulars as to the types offered by different makers of any special instrument may be readily found. To this end the instruments have been arranged in classes, which are in many cases further subdivided, and in addition to a table of contents, an alphabetical list of exhibitors, with general information as to their manufactures, and an index of instruments have been provided. A short introduction to each class furnishes some particulars as to the instruments included thereunder, with notes as to recent advances in the mode of construction.

UNIVERSITY AND EDUCATIONAL NEWS.

PETER B. ROUSS, of New York, son of the late Charles Broadway Rouss, has established at the University of Virginia a memorial to his father by the erection of two adjunct professorships, one of civil, and one of mechanical engineering, to be supported by him, and to be known as the Rouss memorial adjunct professorships.

MR. THOMAS H. SHEVLIN has given $60,000 to the University of Minnesota for a woman's building, which will contain a gymnasium, a luncheon room, etc.

THE Liverpool City Council has agreed to grant a further sum of £10,000 to Liverpool University during the current year.

MR. J. E. CROMBIE has given £1,000 towards the cost of the Aberdeen University quarter-centenary celebration, primarily to guarantee any deficiency in the publication committee's expenses.

THE University at Giessen will celebrate its three hundredth anniversary in May, 1907.

THE Agricultural Department of Clemson College has been reorganized as follows: First, the division devoted to teaching. Second, the division devoted to research work. Under the first head is included the teaching of students, farmers' institute work and extension work. The second division comprises the state experiment station and all lines of original research in the sciences relating to agriculture. The directorship of the station, which office has heretofore rested with the president of the college, has been transferred to the Agricultural Department. A station council has been organized, presided over by the president of the college. This council will meet once a month for the purpose of discussing questions relating to the good of the station and to determine in a general way what shall be the character of the experiments conducted for the coming year. The issuing of all bulletins must be authorized by the station council. All investigations must have the approval of this council. It consists of the president, the director, the professors of chemistry, agriculture, horticulture, entomology and zoology, botany and bacteriology, veterinary science, and animal husbandry and dairying. Under this organization, the following gentlemen comprize the Agricultural Department and are also employed in conducting experiments required by the experiment station. Professor J. N. Harper was elected to fill the place of director of the Agricultural Department and of the station, which post was vacated by the resignation of Professor J. S. Newman, on July 1. Professor Harper comes from the Kentucky state institution. The chair of animal husbandry and dairying has been filled by the election of Professor John Michaels, a graduate of the University of Wisconsin. Professor C. L. Newman, who has recently been elected to the associate professorship of agriculture, was for some years connected with the experiment station at Arkansas.

PROFESSOR W. A. TILDEN, F.R.S., has been appointed dean of the Royal College of Science, South Kensington, in succession to Professor J. W. Judd, F.R.S.

DR. WILLIAM M. HICKS, F.R.S., principal and professor of physics in Sheffield University, has resigned the post of vice-chancellor, and is succeeded by Sir Charles Norton Edgecumbe Eliot.

PROFESSOR E. J. TOWNSEND, of the University of Illinois, has been made acting dean of the College of Science.

DR. ALBERT LEFEVRE, of Tulane University, has been appointed professor of philosophy in the University of Virginia.

PROFESSOR S. J. BUCK has retired from the chair of mathematics at Iowa College, after forty-one years of service. He has been made professor emeritus. Mr. W. J. Rusk, for the past three years associate professor, has been promoted to the chair of mathematics.

MISS MARY C. BLISS, for the past year assistant in botany in Wellesley College, has been advanced to an instructorship, and the following new appointments have been made in the department: Assistant, Miss Maude Cipperly; graduate student assistants, Miss Alice M. Ottley and Miss Emeline Moore.

DR. AUGUST GUTZMAR, professor of mathematics at Jena, has been called to Halle.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, AUGUST 25, 1905.

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

ADDRESS OF THE PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.[1]

I.

BARTHOLOMEU DIAZ, the discoverer of the Cape of Storms, spent sixteen months on his voyage, and the little flotilla of Vasco da Gama, sailing from Lisbon on July 8, 1497, only reached the Cape in the middle of November. These bold men, sailing in their puny fishing-smacks to unknown lands, met the perils of the sea and the attacks of savages with equal courage. How great was the danger of such a voyage may be gathered from the fact that less than half the men who sailed with da Gama lived to return to Lisbon. Four hundred and eight years have passed since that voyage, and a ship of 13,000 tons has just brought us here, in safety and luxury, in but little more than a fortnight.

How striking are the contrasts presented by these events! On the one hand compare the courage, the endurance and the persistence of the early navigators with the little that has been demanded of us; on the other hand consider how much man's power over the forces of nature has been augmented during the past four centuries. The capacity for heroism is probably undiminished, but certainly the occasions are now rarer when it is demanded of us. If we are heroes, at least but few of us ever find it out, and, when we read stories of ancient feats of courage, it is hard to prevent an uneasy thought that, notwithstanding our

[1] Cape Town, August 15, 1905.

boasted mechanical inventions, we are perhaps degenerate descendants of our great predecessors.

Yet the thought that to-day is less romantic and less heroic than yesterday has its consolation, for it means that the lot of man is easier than it was. Mankind, indeed, may be justly proud that this improvement has been due to the successive efforts of each generation to add to the heritage of knowledge handed down to it by its predecessors, whereby we have been born to the accumulated endowment of centuries of genius and labor.

I am told that in the United States the phrase 'I want to know' has lost the simple meaning implied by the words, and has become a mere exclamation of surprise. Such a conventional expression could hardly have gained currency except amongst a people who aspire to knowledge. The dominance of the European race in America, Australasia and South Africa has no doubt arisen from many causes, but amongst these perhaps the chief one is that not only do 'we want to know,' but also that we are determined to find out. And now within the last quarter of a century we have welcomed into the ranks of those who 'want to know' an oriental race, which has already proved itself strong in the peaceful arts of knowledge.

I take it, then, that you have invited us because you want to know what is worth knowing; and we are here because we want to know you, to learn what you have to tell us, and to see that South Africa of which we have heard so much.

The hospitality which you are offering us is so lavish, and the journeys which you have organized are so extensive, that the cynical observer might be tempted to describe our meeting as the largest picnic on record. Although we intend to enjoy our picnic with all our hearts, yet I should like to tell the cynic, if he is here, that perhaps the most important object of these conferences is the opportunity they afford for personal intercourse between men of like minds who live at the remotest corners of the earth.

We shall pass through your land with the speed and the voracity of a flight of locusts; but, unlike the locust, we shall, I hope, leave behind us permanent fertilization in the form of stimulated scientific and educational activity. And this result will ensue whether or not we who have come from Europe are able worthily to sustain the lofty part of prophets of science. We shall try our best to play to your satisfaction on the great stage upon which you call on us to act, and if when we are gone you shall, amongst yourselves, pronounce the performance a poor one, yet the fact will remain, that the meeting has embodied in a material form the desire that the progress of this great continent shall not be merely material; and such an aspiration secures its own fulfilment. However small may be the tangible results of our meeting, we shall always be proud to have been associated with you in your efforts for the advancement of science.

We do not know whether the last hundred years will be regarded forever as the *sæculum mirabile* of discovery, or whether it is but the prelude to yet more marvelous centuries. To us living men, who scarcely pass a year of our lives without witnessing some new marvel of discovery or invention, the rate at which the development of knowledge proceeds is truly astonishing; but from a wider point of view the scale of time is relatively unimportant, for the universe is leisurely in its procedure. Whether the changes which we witness be fast or slow, they form a part of a long sequence of events which begin in some past of immeasurable remoteness and tend

to some end which we can not foresee. It must always be profoundly interesting to the mind of man to trace successive cause and effect in the chain of events which make up the history of the earth and all that lives on it, and to speculate on the origin and future fate of animals, and of planets, suns and stars. I shall try, then, to set forth in my address some of the attempts which have been made to formulate evolutionary speculation. This choice of a subject has, moreover, been almost forced on me by the scope of my own scientific work, and it is, I think, justified by the name which I bear. It will be my fault and your misfortune if I fail to convey to you some part of the interest which is naturally inherent in such researches.

The man who propounds a theory of evolution is attempting to reconstruct the history of the past by means of the circumstantial evidence afforded by the present. The historian of man, on the other hand, has the advantage over the evolutionist in that he has the written records of the past on which to rely. The discrimination of the truth from amongst discordant records is frequently a work demanding the highest qualities of judgment; yet when this end is attained it remains for the historian to convert the arid skeleton of facts into a living whole by clothing it with the flesh of human motives and impulses. For this part of his task he needs much of that power of entering into the spirit of other men's lives which goes to the making of a poet. Thus the historian should possess not only the patience of the man of science in the analysis of facts, but also the imagination of the poet to grasp what the facts have meant. Such a combination is rarely to be found in equal perfection on both sides, and it would not be hard to analyze the works of great historians so as to see which quality was predominant in each of them.

The evolutionist is spared the surpassing difficulty of the human element, yet he also needs imagination, although of a different character from that of the historian. In its lowest form his imagination is that of the detective who reconstructs the story of a crime; in its highest it demands the power of breaking loose from all the trammels of convention and education, and of imagining something which has never occurred to the mind of man before. In every case the evolutionist must form a theory for the facts before him, and the great theorist is only to be distinguished from the fantastic fool by the sobriety of his judgment—a distinction, however, sufficient to make one rare and the other only too common.

The test of a scientific theory lies in the number of facts which it groups into a connected whole; it ought besides to be fruitful in pointing the way to the discovery and coordination of new and previously unsuspected facts. Thus a good theory is in effect a cyclopedia of knowledge, susceptible of indefinite extension by the addition of supplementary volumes.

Hardly any theory is all true, and many are not all false. A theory may be essentially at fault and yet point the way to truth, and so justify its temporary existence. We should not, therefore, totally reject one or other of two rival theories on the ground that they seem, with our present knowledge, mutually inconsistent, for it is likely that both may contain important elements of truth. The theories of which I shall have to speak hereafter may often appear discordant with one another according to our present lights. Yet we must not scruple to pursue the several divergent lines of thought to their logical conclusions, relying on future discovery to eliminate the false and to reconcile together the truths which form part of each of them.

In the mouths of the unscientific evolu-

tion is often spoken of as almost synonymous with the evolution of the various species of animals on the earth, and this again is sometimes thought to be practically the same thing as the theory of natural selection. Of course those who are conversant with the history of scientific ideas are aware that a belief in the gradual and orderly transformation of nature, both animate and inanimate, is of great antiquity.

We may liken the facts on which theories of evolution are based to a confused heap of beads, from which a keen-sighted searcher after truth picks out and strings together a few which happen to catch his eye, as possessing certain resemblances. Until recently, theories of evolution in both realms of nature were partial and discontinuous, and the chains of facts were correspondingly short and disconnected. At length the theory of natural selection, by formulating the cause of the divergence of forms in the organic world from the parental stock, furnished the naturalist with a clue by which he examined the disordered mass of facts before him, and he was thus enabled to go far in deducing order where chaos had ruled before, but the problem of reducing the heap to perfect order will probably baffle the ingenuity of the investigator forever.

So illuminating has been this new idea that, as the whole of nature has gradually been reexamined by its aid, thousands of new facts have been brought to light, and have been strung in due order on the necklace of knowledge. Indeed, the transformation resulting from the new point of view has been so far-reaching as almost to justify the misapprehension of the unscientific as to the date when the doctrines of evolution first originated in the mind of man.

It is not my object, nor indeed am I competent, to examine the extent to which the theory of natural selection has needed modification since it was first formulated by my father and Wallace. But I am surely justified in maintaining that the general principle holds its place firmly as a permanent acquisition to modes of thought.

Evolutionary doctrines concerning inanimate nature, although of much older date than those which concern life, have been profoundly affected by the great impulse of which I have spoken. It has thus come about that the origin and history of the chemical elements and of stellar systems now occupy a far larger space in the scientific mind than was formerly the case. The subject which I shall discuss to-night is the extent to which ideas parallel to those which have done so much towards elucidating the problems of life, hold good also in the world of matter; and I believe that it will be possible to show that in this respect there exists a resemblance between the two realms of nature, which is not merely fanciful. It is proper to add that as long ago as 1873 Baron Karl du Prel discussed the same subject from a similar point of view, in a book entitled 'The Struggle for Life in the Heavens.'[1]

Although inanimate matter moves under the action of forces which are incomparably simpler than those governing living beings, yet the problems of the physicist and the astronomer are scarcely less complex than those which present themselves to the biologist. The mystery of life remains as impenetrable as ever, and in his evolutionary speculations the biologist does not attempt to explain life itself, but, adopting as his unit the animal as a whole, discusses its relationships to other animals and to the surrounding conditions. The physicist, on the other hand, is irresistibly impelled to form theories as to the intimate

[1] *Der Kampf um's Dasein am Himmel* (zweite Auflage), Denicke, Berlin, 1876.

constitution of the ultimate parts of matter, and he desires further to piece together the past histories and the future fates of planets, stars and nebulæ. If then the speculations of the physicist seem in some respects less advanced than those of the biologist, it is chiefly because he is more ambitious in his aims. Physicists and astronomers have not yet found their Johannesburg or Kimberley; but, although we are still mere prospectors, I am proposing to show you some of the dust and diamonds which we have already extracted from our surface mines.

The fundamental idea in the theory of natural selection is the persistence of those types of life which are adapted to their surrounding conditions, and the elimination by extermination of ill-adapted types. The struggle for life amongst forms possessing a greater or less degree of adaptation to slowly varying conditions is held to explain the gradual transmutation of species. Although a different phraseology is used when we speak of the physical world, yet the idea is essentially the same.

The point of view from which I wish you to consider the phenomena of the world of matter may be best explained if, in the first instance, I refer to political institutions, because we all understand, or fancy we understand, something of politics, whilst the problems of physics are commonly far less familiar to us. This illustration will have a further advantage in that it will not be a mere parable, but will involve the fundamental conception of the nature of evolution.

The complex interactions of man with man in a community are usually described by such comprehensive terms as the state, the commonwealth, or the government. Various states differ widely in their constitution and in the degree of the complexity of their organization, and we classify them by various general terms, such as autocracy, aristocracy or democracy, which express somewhat loosely their leading characteristics. But, for the purpose of showing the analogy with physics, we need terms of wider import than those habitually used in politics. All forms of the state imply inter-relationship in the actions of men, and action implies movement. Thus the state may be described as a configuration or arrangement of a community of men; or we may say that it implies a definite mode of motion of man—that is to say an organized scheme of action of man on man. Political history gives an account of the gradual changes in such configurations or modes of motion of men as have possessed the quality of persistence or of stability to resist the disintegrating influence of surrounding circumstances.

In the world of life the naturalist describes those forms which persist as species; similarly the physicist speaks of stable configurations or modes of motion of matter; and the politician speaks of states. The idea at the base of all these conceptions is that of stability, or the power of resisting disintegration. In other words, the degree of persistence or permanence of a species, of a configuration of matter or of a state depends on the perfection of its adaptation to its surrounding conditions.

If we trace the history of a state we find the degree of its stability gradually changing, slowly rising to a maximum, and then slowly declining. When it falls to nothing a revolution ensues, and a new form of government is established. The new mode of motion or government has at first but slight stability, but it gradually acquires strength and permanence, until in its turn the slow decay of stability leads on to a new revolution.

Such crises in political history may give

rise to a condition in which the state is incapable of perpetuation by transformation. This occurs when a savage tribe nearly exterminates another tribe and leads the few survivors into slavery; the previous form of government then becomes extinct.

The physicist, like the biologist and the historian, watches the effect of slowly varying external conditions; he sees the quality of persistence or stability gradually decaying until it vanishes, when there ensues what is called, in politics, a revolution.

These considerations lead me to express a doubt whether biologists have been correct in looking for continuous transformation of species. Judging by analogy we should rather expect to find slight continuous changes occurring during a long period of time, followed by a somewhat sudden transformation into a new species, or by rapid extinction. However this may be, when the stability of a mode of motion vanishes, the physicist either finds that it is replaced by a new persistent type of motion adapted to the changed conditions, or perhaps that no such transformation is possible and that the mode of motion has become extinct. The evanescent type of animal life has often been preserved for us, fossilized in geological strata; the evanescent form of government is preserved in written records or in the customs of savage tribes; but the physicist has to pursue his investigations without such useful hints as to the past.

The time-scale in the transmutation of species of animals is furnished by the geological record, although it is not possible to translate that record into years. As we shall see hereafter, the time needed for a change of type in atoms or molecules may be measured by millionths of a second, while in the history of the stars continuous changes occupy millions of years. Notwithstanding this gigantic contrast in speed the process involved seems to be essentially the same.

It is hardly too much to assert that, if the conditions which determine stability of motion could be accurately formulated throughout the universe, the past history of the cosmos and its future fate would be unfolded. How indefinitely far we stand removed from such a state of knowledge will become abundantly clear from the remainder of my address.

The study of stability and instability then furnishes the problems which the physicist and biologist alike attempt to solve. The two classes of problems differ principally in the fact that the conditions of the world of life are so incomparably more intricate than those of the world of matter that the biologist is compelled to abandon the attempt to determine the absolute amount of the influence of the various causes which have affected the existence of species. His conclusions are merely qualitative and general, and he is almost universally compelled to refrain from asserting even in general terms what are the reasons which have rendered one form of animal life stable and persistent, and another unstable and evanescent.

On the other hand, the physicist, as a general rule, does not rest satisfied unless he obtains a quantitative estimate of various causes and effects on the systems of matter which he discusses. Yet there are some problems of physical evolution in which the conditions are so complex that the physicist is driven, as is the biologist, to rest satisfied with qualitative rather than quantitative conclusions. But he is not content with such crude conclusions except in the last resort, and he generally prefers to proceed by a different method.

The mathematician mentally constructs

an ideal mechanical system or model, which is intended to represent in its leading features the system he wants to examine. It is often a task of the utmost difficulty to devise such a model, and the investigator may perchance unconsciously drop out as unimportant something which is really essential to represent actuality. He next examines the conditions of his ideal system, and determines, if he can, all the possible stable and unstable configurations, together with the circumstances which will cause transitions from one to the other. Even when the working model has been successfully imagined, this latter task may often overtax the powers of the mathematician. Finally it remains for him to apply his results to actual matter, and to form a judgment of the extent to which it is justifiable to interpret nature by means of his results.

The remainder of my address will be occupied by an account of various investigations which will illustrate the principles and methods which I have now explained in general terms.

The fascinating idea that matter of all kinds has a common substratum is of remote antiquity. In the middle ages the alchemists, inspired by this idea, conceived the possibility of transforming the baser metals into gold. The sole difficulty seemed to them the discovery of an appropriate series of chemical operations. We now know that they were always indefinitely far from the goal of their search, yet we must accord to them the honor of having been the pioneers of modern chemistry.

The object of alchemy, as stated in modern language, was to break up or dissociate the atoms of one chemical element into its component parts, and afterwards to reunite them into atoms of gold. Although even the dissociative stage of the alchemistic problem still lies far beyond the power of the chemist, yet modern researches seem to furnish a sufficiently clear idea of the structure of atoms to enable us to see what would have to be done to effect a transformation of elements. Indeed, in the complex changes which are found to occur spontaneously in uranium, radium and the allied metals we are probably watching a spontaneous dissociation and transmutation of elements.

Nature selection may seem, at first sight, as remote as the poles asunder from the ideas of the alchemist, yet dissociation and transmutation depend on the instability and regained stability of the atom, and the survival of the stable atom depends on the principle of natural selection.

Until some ten years ago the essential diversity of the chemical elements was accepted by the chemist as an ultimate fact, and indeed the very name of atom, or that which can not be cut, was given to what was supposed to be the final indivisible portion of matter. The chemist thus proceeded in much the same way as the biologist who, in discussing evolution, accepts the species as his working unit. Accordingly, until recently the chemist discussed working models of matter of atomic structure, and the vast edifice of modern chemistry has been built with atomic bricks.

But within the last few years the electrical researches of Lenard, Röntgen, Becquerel, the Curies, of my colleagues Larmor and Thomson, and of a host of others, have shown that the atom is not indivisible, and a flood of light has been thrown thereby on the ultimate constitution of matter. Amongst all these fertile investigators it seems to me that Thomson stands preeminent, because it is principally through him that we are to-day in a better position for picturing the structure of an atom than was ever the case before.

Even if I had the knowledge requisite for a complete exposition of these investigations, the limits of time would compel me to confine myself to those parts of the subject which bear on the constitution and origin of the elements.

It has been shown, then, that the atom, previously supposed to be indivisible, really consists of a large number of component parts. By various convergent lines of experiment it has been proved that the simplest of all atoms—namely, that of hydrogen—consists of about 800 separate parts; while the number of parts in the atom of the denser metals must be counted by tens of thousands. These separate parts of the atom have been called corpuscles or electrons, and may be described as particles of negative electricity. It is paradoxical, yet true, that the physicist knows more about these ultra-atomic corpuscles and can more easily count them than is the case with the atoms of which they form the parts.

The corpuscles, being negatively electrified, repel one another just as the hairs on a person's head mutually repel one another when combed with a vulcanite comb. The mechanism is as yet obscure whereby the mutual repulsion of the negative corpuscles is restrained from breaking up the atom, but a positive electrical charge, or something equivalent thereto, must exist in the atom, so as to prevent disruption. The existence in the atom of this community of negative corpuscles is certain, and we know further that they are moving with speeds which may in some cases be comparable to the volocity of light, namely, 200,000 miles a second. But the mechanism whereby they are held together in a group is hypothetical.

It is only just a year ago that Thomson suggested, as representing the atom, a mechanical or electrical model whose properties could be accurately examined by mathematical methods. He would be the first to admit that his model is at most merely a crude representation of actuality, yet he has been able to show that such an atom must possess mechanical and electrical properties which simulate, with what Whetham describes as 'almost Satanic exactness,' some of the most obscure and yet most fundamental properties of the chemical elements. 'Se non è vero, è ben trovato,' and we are surely justified in believing that we have the clue which the alchemists sought in vain.

Thomson's atom consists of a globe charged with positive electricity, inside which there are some thousand or thousands of corpuscles of negative electricity, revolving in regular orbits with great velocities. Since two electrical charges repel one another if they are of the same kind, and attract one another if they are of opposite kinds, the corpuscles mutually repel one another, but all are attracted by the globe containing them. The forces called into play by these electrical interactions are clearly very complicated, and you will not be surprised to learn that Thomson found himself compelled to limit his detailed examination of the model atom to one containing about seventy corpuscles. It is indeed a triumph of mathematical power to have determined the mechanical conditions of such a miniature planetary system as I have described.

It appears that there are definite arrangements of the orbits in which the corpuscles must revolve, if they are to be persistent or stable in their motions. For the purpose of general discussion, which is all that I shall attempt, you may take it that the number of corpuscles in such a community is fixed; and we may state that definite numbers of corpuscles are capable

of association in stable communities of definite types.

An infinite number of communities are possible, possessing greater or lesser degrees of stability. Thus the corpuscles in one such community might make thousands of revolutions in their orbits before instability declared itself; such an atom might perhaps last for a long time as estimated in millionths of seconds, but it must finally break up and the corpuscles must disperse or rearrange themselves after the ejection of some of their number. We are thus led to conjecture that the several chemical elements represent those different kinds of communities of corpuscles which have proved by their stability to be successful in the struggle for life. If this is so, it is almost impossible to believe that the successful species have existed for all time, and we must hold that they originated under conditions about which I must forbear to follow Sir Norman Lockyer in speculating.

But if the elements were not eternal in the past, we must ask whether there is reason to believe that they will be eternal in the future. Now, although the conception of the decay of an element and its spontaneous transmutation into another element would have seemed absolutely repugnant to the chemist until recently, yet analogy with other moving systems seems to suggest that the elements are not eternal.

At any rate it is of interest to pursue to its end the history of the model atom which has proved to be so successful in imitating the properties of matter. The laws which govern electricity in motion indicate that such an atom must be radiating or losing energy, and therefore a time must come when it will run down, as a clock does. When this time comes it will spontaneously transmute itself into an element which needs less energy than was required in the former state. Thomson conceives that an atom might be constructed after his model so that its decay should be very slow. It might, he thinks, be made to run for a million years, but it would not be eternal.

Such a conclusion is an absolute contradiction to all that was known of the elements until recently, for no symptoms of decay are perceived, and the elements existing in the solar system must already have lasted for millions of years. Nevertheless, there is good reason to believe that in radium, and in other elements possessing very complex atoms, we do actually observe that break-up and spontaneous rearrangement which constitute a transmutation of elements.

It is impossible as yet to say how science will solve this difficulty, but future discovery in this field must surely prove deeply interesting. It may well be that the train of thought which I have sketched will ultimately profoundly affect the material side of human life, however remote it may now seem from our experiences of daily life.

I have not as yet made any attempt to represent the excessive minuteness of the corpuscles, of whose existence we are now so confident; but, as an introduction to what I have to speak of next, it is necessary to do so. To obtain any adequate conception of their size we must betake ourselves to a scheme of threefold magnification. Lord Kelvin has shown that if a drop of water were magnified to the size of the earth the molecules of water would be of a size intermediate between that of a cricket-ball and of a marble. Now each molecule contains three atoms, two being of hydrogen and one of oxygen. The molecular system probably presents some sort of analogy with that of a triple star; the three atoms, replacing the stars, revolving about one another in some sort of dance which can not be exactly described. I doubt

whether it is possible to say how large a part of the space occupied by the whole molecule is occupied by the atoms; but perhaps the atoms bear to the molecule some such relationship as the molecule to the drop of water referred to. Finally, the corpuscles may stand to the atom in a similar scale of magnitude. Accordingly, a threefold magnification would be needed to bring these ultimate parts of the atom within the range of our ordinary scales of measurement.

I have already considered what would be observed under the triply powerful microscope, and must now return to the intermediate stage of magnification, in which we consider those communities of atoms which form molecules. This is the field of research of the chemist. Although prudence would tell me that it would be wiser not to speak of a subject of which I know so little, yet I can not refrain from saying a few words.

The community of atoms in water has been compared with a triple star, but there are others known to the chemist in which the atoms are to be counted by fifties and hundreds, so that they resemble constellations.

I conceive that here again we meet with conditions similar to those which we have supposed to exist in the atom. Communities of atoms are called chemical combinations, and we know that they possess every degree of stability. The existence of some is so precarious that the chemist in his laboratory can barely retain them for a moment; others are so stubborn that he can barely break them up. In this case dissociation and reunion into new forms of communities are in incessant and spontaneous progress throughout the world. The more persistent or more stable combinations succeed in their struggle for life, and are found in vast quantities, as in the cases of common salt and of the combinations of silicon. But no one has ever found a mine of guncotton, because it has so slight a power of resistance. If, through some accidental collocation of elements, a single molecule of guncotton were formed, it would have but a short life.

Stability is, further, a property of relationship to surrounding conditions; it denotes adaptation to environment. Thus salt is adapted to the struggle for existence on the earth, but it can not withstand the severer conditions which exist in the sun.

G. H. Darwin.
University of Cambridge.

[The president here announced that he proposed to consider various theories of evolution in the heavens in the second portion of his address, to be delivered at Johannesburg on Wednesday, August 30.]

ADDRESS TO THE MATHEMATICAL AND PHYSICAL SECTION OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.[1]

According to an established and unchallenged custom, our proceedings are inaugurated by an address from the president. Let me begin it by discharging a duty which, unhappily, is of regular recurrence. If your president only mentions names when he records the personal losses suffered during the year by the sciences of the section, the corporate sense of the section will be able to appreciate the losses with a deeper reality than can be conveyed by mere words.

In Mr. Ronald Hudson, who was one of our secretaries at the Cambridge meeting a year ago, we have lost a mathematician whose youthful promise had ripened into early performance. The original work which he had accomplished is sufficient, both in quality and in amount, to show that much has been given, and that much more

[1] South Africa, 1905.

could have been expected. His alert and bright personality suggested that many happy years lay before him. All these fair hopes were shattered in a moment by an accident upon a Welsh hillside; and his friends, who were many, deplore his too early death at the age of twenty-eight.

The death of Mr. Frank McClean has robbed astronomy of one of its most patient workers and actively creative investigators. I wish that my own knowledge could enable me to give some not inadequate exposition of his services to the science which he loved so well. He was a man of great generosity which was wise, discriminating and more than modest; to wide interests in science he united wide interests in the fine arts. Your astronomer royal, in the Royal Observatory at Cape Town, will not lightly forget his gift of a great telescope: and the University of Cambridge, the grateful recipient of his munificent endowment of the Isaac Newton studentships fifteen years ago, and of his no less munificent bequest of manuscripts, early printed books, and objects of art, has done what she can towards perpetuating his memory for future generations by including his name in the list, that is annually recited in solemn service, of her benefactors who have departed this life.

In the early days of our gatherings, when the set of cognate sciences with which we specially are concerned had not yet diverged so widely from one another alike in subject and in method, this inaugurating address was characterized by a brevity that a president can envy and by a freedom from formality that even the least tolerant audience could find admirable. The lapse of time, perhaps assisted by presidential ambitions which have been veiled under an almost periodic apology for personal shortcomings, has deprived these addresses of their ancient brevity, and has invested them with an air of oracular gravity. The topics vary from year to year, but this variation is due to the predilection of the individual presidents; the types of address are but few in number. Sometimes, indeed, we have had addresses that can not be ranged under any comprehensive type. Thus one year we had an account of a particular school of long-sustained consecutive research; another year the president made a constructive (and perhaps defiant) defence of the merits of a group of subjects that were of special interest to himself. But there is one type of address which recurs with iterated frequency; it is constituted by a general account of recent progress in discovery, or by a survey of modern advances in some one or other of the branches of science to which the multiple activities of our section are devoted. No modern president has attempted a general survey of recent progress in all the branches of our group of sciences; such an attempt will probably be deferred until the council discovers a president who, endowed with the omniscience of a Whewell, and graced with the tongue of men and of angels, shall once again unify our discussions.

On the basis of this practise, it would have been not unreasonable on my part to have selected some topic from the vast range of pure mathematics, and to have expounded some body of recent investigations. There certainly is no lack of topics; our own day is peculiarly active in many directions. Thus, even if we leave on one side the general progress that has been made in many of the large branches of mathematics during recent years, it is easy to hint at numerous subjects which could occupy the address of a mathematical president. He might, for instance, devote his attention to modern views of continuity, whether of quantity or of space; he might be heterodox or orthodox as to the so-called laws of motion; he might expound his

notions as to the nature and properties of analytic functionality; a discussion of the hypotheses upon which a consistent system of geometry can be framed could be made as monumental as his ambition might choose; he could revel in an account of the most recent philosophical analysis of the foundations of mathematics, even of logic itself, in which all axioms must either be proved or be compounded of notions that defy resolution by the human intellect at the present day. Such discussions are bound to be excessively technical unless they are expressed in unmathematical phraseology; when they are so expressed, and in so far as such expression is possible, they become very long and they can be very thin. Moreover, had I chosen any topic of this character, it would have been the merest natural justice to have given early utterance of the sibyllic warning to the uninitiated; I must also have bidden the initiated that, as they come, they should summon all the courage of their souls. So I abstain from making such an experiment upon an unwarned audience; yet it is with reluctance that I have avoided subjects in the range which to me is of peculiar interest.

On the other hand, I must ask your indulgence for not conforming to average practice and expectation. My desire is to mark the present occasion by an address of unspecialized type which, while it is bound to be mainly mathematical in tenor, and while it will contain no new information, may do little more than recall some facts that are known, and will comment briefly upon obvious tendencies. Let me beg you to believe that it is no straining after novelty which has dictated my choice; such an ambition has a hateful facility of being fatal both to the performer and to the purpose. It is the strangeness of our circumstances, in both place and time, that has suggested my subject. With an adventurous audacity that quite overcrows the spirit of any of its past enterprises, the British Association for the Advancement of Science has traveled south of the Equator and, in accepting your hospitality, proposes to traverse much of South Africa. The prophet of old declared that 'many shall run to and fro, and knowledge shall be increased'; if the second part of the prophecy is not fulfilled, it will not be for the want of our efforts to fulfill the first part. And if the place and the range of this peripatetic demonstration of our annual corporate activity are unusual, the occasion chosen for this enterprise recalls memories that are fundamental in relation to our subject. It is a modern fashion to observe centenaries. In this section we are in the unusual position of being able to observe three scientific centenaries in one and the same year. Accordingly I propose to refer to these in turn, and to indicate a few of the events filling the intervals between them; but my outline can be of only the most summary character, for the scientific history is a history of three hundred years, and, if searching enough, it could include the tale of nearly all mathematical and astronomical and physical science.

It is exactly three hundred years since Bacon published 'The Advancement of Learning.' His discourse, alike in matter, in thought, in outlook, was in advance of its time, and it exercised no great influence for the years that immediately followed its appearance; yet that appearance is one of the chief events in the origins of modern natural science. Taking all knowledge to be his province, he surveys the whole of learning: he deals with the discredits that then could attach to it; he expounds both the dignity and the influence of its pursuit; and he analyzes all learning, whether of things divine or of things human, into

its ordered branches. He points out deficiencies and gaps; not a few of his recommendations of studies, at his day remaining untouched, have since become great branches of human thought and human inquiry. But what concerns us most here is his attitude towards natural philosophy, all the more remarkable because of the state of knowledge of that subject in his day, particularly in England. It is true that Gilbert had published his discovery of terrestrial magnetism some five years earlier, a discovery followed only too soon by his death; but that was the single considerable English achievement in modern science down to Bacon's day.

In order to estimate the significance of Bacon's range of thought let me recite a few facts, as an indication of the extreme tenuity of progressive science in that year (1605). They belong to subsequent years, and may serve to show how restricted were the attainments of the period, and how limited were the means of advance. The telescope and the microscope had not yet been invented. The simple laws of planetary motion were not formulated, for Kepler had them only in the making. Logarithms were yet to be discovered by Napier, and to be calculated by Briggs. Descartes was a boy of nine and Fermat a boy of only four, so that analytical geometry, the middle-life discovery of both of them, was not yet even a dream for either of them. The Italian mathematicians, of whom Cavalieri is the least forgotten, were developing Greek methods of quadrature by a transformed principle of indivisibles; but the infinitesimal calculus was not really in sight, for Newton and Leibnitz were yet unborn. Years were to elapse before, by the ecclesiastical tyranny over thought, Galileo was forced to make a verbal disavowal of his adhesion to the Copernican system of astronomy, of which he was still to be the protagonist in propounding any reasoned proof. Some mathematics could be had, cumbrous arithmetic and algebra, some geometry lumbering after Euclid, and a little trigonometry; but these were mainly the mathematics of the Renaissance, no very great advance upon the translated work of the Greeks and the transmitted work of the Arabs. Even our old friend the binomial theorem, which now is supposed to be the possession of nearly every able schoolboy, remained unknown to professional mathematicians for more than half a century yet to come.

Nor is it merely on the negative side that the times seemed unpropitious for a new departure; the spirit of the age in the positive activities of thought and deed was not more sympathetic. Those were the days when the applications of astronomy had become astrology. Men sought for the elixir of life and pondered over the transmutation of baser metals into gold. Shakespeare not long before had produced his play 'As You Like It,' where the strange natural history of the toad which,

> Ugly and venomous,
> Bears yet a precious jewel in his head,

is made a metaphor to illustrate the sweetening uses of adversity. The stiffened Elizabethan laws against witchcraft were to be sternly administered for many a year to come. It was an age that was pulsating with life and illuminated by fancy, but the life was the life of strong action and the fancy was the fancy of ideal imagination; men did not lend themselves to sustained and abstract thought concerning the nature of the universe. When we contemplate the spirit that such a state of knowledge might foster towards scientific learning, and when we recall the world into which Bacon's treatise was launched, we can well be surprised at his far-reaching views, and we can marvel at his isolated wisdom.

Let me select a few specimens of his judgments, chosen solely in relation to our own subjects. When he says

> All true and fruitful natural philosophy hath a double scale or ladder, ascendent and descendent, ascending from experiments to the invention of causes, and descending from causes to the invention of new experiments; therefore I judge it most requisite that these two parts be severally considered and handled—

he is merely expounding, in what now is rather archaic phrase, the principles of the most ambitious investigations in the natural philosophy of subsequent centuries. When he speaks of

> the operation of the relative and adventive characters of essences, as quantity, similitude, diversity, possibility and the rest; with this distinction and provision, that they be handled as they have efficacy in nature, and not logically—

I seem to hear the voice of the applied mathematician warning the pure mathematician off the field. When, after having divided natural philosophy into physic and metaphysic (using these words in particular meanings, and including mathematics in the second of the divisions), he declares

> physics should contemplate that which is inherent in matter, and therefore transitory, and metaphysics that which is abstracted and fixed; * * * physic describeth the causes of things, but the variable or respective causes; and metaphysic the fixed and constant causes—

there comes before my mind the army of physicists of the present day, who devote themselves unwearyingly to the properties of matter and willingly cast aside elaborate arguments and calculations. When he argues that

> many parts of nature can neither be invented with sufficient subtilty, nor demonstrated with sufficient perspicuity, nor accommodated unto use with sufficient dexterity, without the aid and intervening of the mathematics—

he might be describing the activity of subsequent generations of philosophers, astronomers and engineers. And in the last place (for my extracts must have some end), when he expresses the opinion

> that men do not sufficiently understand the excellent use of the pure mathematics, in that they do remedy and cure many defects in the wit and faculties intellectual. For if the wit be too dull, they sharpen it; if too wandering, they fix it; if too inherent in the sense, they abstract it; * * * in the mathematics, that which is collateral and intervenient is no less worthy than that which is principal and intended—

I seem to hear an advocate for the inclusion of elementary mathematics in any scheme of general education. At the same time, I wonder what Bacon, who held such an exalted estimate of pure mathematics in its gray dawn, would have said by way of ampler praise of the subject in its fuller day.

It was a splendid vision of inductive science as of other parts of learning: it contained a revelation of the course of progress through the centuries to come. Yet the facts of to-day are vaster than the vision of that long-ago yesterday, and human activity has far outstripped the dreams of Bacon's opulent imagination. He was the harbinger (premature in many respects it must be confessed, but still the harbinger) of a new era. At a time when we are making a new departure in the fulfilment of the purpose of our charter, which requires us 'to promote the intercourse of those who cultivate science in different parts of the British Empire, our Association for the Advancement of Science may pause for a moment to gaze upon the vision revealed three centuries ago in the 'Advancement of Learning' by a philosopher whose influence upon the thought of the world is one of the glories of our nation.

I have implied that Bacon's discourse was in advance of its age, so far as England was concerned. Individuals could make their mark in isolated fashion. Thus Harvey, in his hospital work in London, discovered the circulation of the blood; Na-

pier, away on his Scottish estates, invented logarithms; and Horrocks, in the seclusion of a Lancashire curacy, was the first to observe a transit of Venus. But for more than half a century the growth of physical science was mainly due to workers on the continent of Europe. Galileo was making discoveries in the mechanics of solids and fluids, and, specially, he was building on a firm foundation the fabric of the system of astronomy, hazarded nearly a century before by Copernicus; he still was to furnish, by bitter experience, one of the most striking examples in the history of the world that truth is stronger than dogma. Kepler was gradually elucidating the laws of planetary motion, of which such significant use was made later by Newton; and Descartes, by his creation of analytical geometry, was yet to effect such a constructive revolution in mathematics that he might not unfairly be called the founder of modern mathematics. In England the times were out of scientific joint: the political distractions of the Stuart troubles, and the narrow theological bitterness of the commonwealth, made a poor atmosphere for the progress of scientific learning, which was confined almost to a faithful few. The fidelity of those few, however, had its reward; it was owing to their steady confidence and to their initiative that the Royal Society of London was founded in 1662 by Charles II. At that epoch, science (to quote the words of a picturesque historian) became the fashion of the day. Great Britain began to contribute at least her fitting share to the growing knowledge of nature; and her scientific activity in the closing part of the seventeenth century was a realization, wonderful and practical, of a part of Bacon's dream. Undoubtedly the most striking contribution made in that period is Newton's theory of gravitation, as expounded in his 'Principia,' published in 1687.

That century also saw the discovery of the fluxional calculus by Newton, and of the differential calculus by Leibnitz. These discoveries provided the material for one of the longest and most deadening controversies as to priority in all the long history of those tediously barren occupations; unfortunately they are dear to minds which cannot understand that a discovery should be used, developed, amplified, but should not be a cause of envy, quarrel, or controversy. Let me say, incidentally, that the controversy had a malign influence upon the study of mathematics as pursued in England.

Also, the undulatory theory of light found its first systematic, if incomplete, exposition in the work of Huygens before the century was out. But Newton had an emission theory of his own, and so the undulatory theory of Huygens found no favor in England until rather more than a hundred years later; the researches of Thomas Young established it on a firm foundation.

Having thus noted some part of the stir in scientific life which marked the late years of the seventeenth century, let me pass to the second of our centenaries: it belongs to the name of Edmond Halley. Quite independently of his achievement connected with the year 1705 to which I am about to refer, there are special reasons for honoring Halley's name in this section at our meeting in South Africa. When a young man of twenty-one he left England for St. Helena, and there, in the years 1676–1678, he laid the foundations of stellar astronomy for the southern hemisphere; moreover, in the course of his work he there succeeded in securing the first complete observation of a transit of Mercury. After his return to England, the next few years of his life were spent in laying science under a special debt that can hardly be over-appreciated. He placed himself in personal relation with Newton, propounded to him questions and

offered information; and it is now a commonplace statement that Halley's questions and suggestions caused Newton to write the 'Principia.' More than this, we know that Newton's great treatise saw the light only through Halley's persuasive insistence, through his unwearying diligence in saving Newton all cares and trouble and even pecuniary expense, and through his absolutely self-sacrificing devotion to what he made an unwavering duty at that epoch in his life. Again, he appears to have been the first organizer of a scientific expedition, as distinct from a journey of discovery, towards the southern seas: he sailed as far as the fifty-second degree of southern latitude, devised the principle of the sextant in the course of his voyaging, and, as a result of the voyage, he produced a general chart of the Atlantic Ocean, with special reference to the deviation of the compass. Original, touched with genius, cheery of soul, strenuous in thought and generous by nature, he spent his life in a continuously productive devotion to astronomical science, from boyhood to a span of years far beyond that which satisfied the psalmist's broodings. I have selected a characteristic incident in his scientific activity, one of the most brilliant (though it can not be claimed as the most important) of his astronomical achievements; it strikes me as one of the most chivalrously bold acts of convinced science within my knowledge. It is only the story of a comet.

I have just explained, very briefly, Halley's share in the production of Newton's 'Principia'; his close concern with it made him the Mahomet of the new dispensation of the astronomical universe, and he was prepared to view all its phenomena in the light of that dispensation. A comet had appeared in 1682—it was still the age when scientific men could think that, by a collision between the earth and a comet, 'this most beautiful order of things would be entirely destroyed and reduced to its ancient chaos'; but this fear was taken as a 'by-the-bye,' which happily interfered with neither observations nor calculations. Observations had duly been made. The data were used to obtain the elements of the orbit, employing Newton's theory as a working hypothesis; and he expresses an incidental regret as to the intrinsic errors of assumed numerical elements and of recorded observations. It then occurred to Halley to calculate similarly the elements of the comet which Kepler and others had seen in 1607, and of which records had been made; the Newtonian theory gave elements in close accord with those belonging to the comet calculated from the latest observations, though a new regret is expressed that the 1607 observations had not been made with more accuracy. On these results he committed himself (being then a man of forty-nine years of age) to a prophecy (which could not be checked for fifty-three years to come) that the comet would return about the end of the year 1758 or the beginning of the next succeeding year; he was willing to leave his conclusion 'to be discussed by the care of posterity, after the truth is found out by the event.' But not completely content with this stage of his work, he obtained with difficulty a book by Apian, giving an account of a comet seen in 1531 and recording a number of observations. Halley, constant to his faith in the Newtonian hypothesis, used that hypothesis to calculate the elements of the orbit of the Apian comet; once more regretting the uncertainty of the data and discounting a very grievous error committed by Apian himself, Halley concluded that the Apian comet of 1531, and the Kepler comet of 1607, and the observed comet of 1682 were one and the same. He confirmed his prediction as to the date of its return, and he

concludes his argument with a blend of confidence and patriotism:—

> **Wherefore if according to what we have already said it should return again about the year 1758, candid posterity will not refuse to acknowledge that this was first discovered by an *Englishman*.**

Such was Halley's prediction published in the year 1705. The comet pursued its course, and it was next seen on Christmas Day, 1758. Candid posterity, so far from refusing to acknowledge that the discovery was made by an Englishman, has linked Halley's name with the comet, possibly for all time.

We all now could make announcements on the subject of Halley's comet; their fulfilment could be awaited serenely. No vision or inspiration is needed; calculations and corrections will suffice. The comet was seen in 1835, and it is expected again in 1910. No doubt our astronomers will be ready for it; and the added knowledge of electrical science, in connection particularly with the properties of matter, may enable them to review Bessel's often-discussed conjecture as to an explanation of the emission of a sunward tail. But Halley's announcement was made during what may be called the immaturity of the gravitation theory; the realization of the prediction did much to strengthen the belief in the theory and to spread its general acceptance; the crown of conviction was attained with the work of Adams and Leverrier in the discovery, propounded by theory and verified by observation, of the planet Neptune. I do not known an apter illustration of Bacon's dictum that has already been quoted, 'All true and fruitful natural philosophy hath a double scale, ascending from experiments to the invention of causes, and descending from causes to the invention of new experiments.' The double process, when it can be carried out, is one of the most effective agents for the increase of trustworthy knowledge. But until the event justified Halley's prediction, the Cartesian vortex-theory of the universe was not completely replaced by the Newtonian theory; the Cartesian votaries were not at once prepared to obey Halley's jubilant, if stern, injunction to 'leave off trifling * * * with their vortices and their absolute plenum * * * and give themselves up to the study of truth.'

The century that followed the publication of Halley's prediction shows a world that is steadily engaged in the development of the inductive sciences and their applications. Observational astronomy continued its activity quite steadily, reinforced towards the end of the century by the first of the Herschels. The science of mathematical (or theoretical) astronomy was created in a form that is used to this day; but before this creation could be effected there had to be a development of mathematics suitable for the purpose. The beginnings were made by the Bernoullis (a family that must be of supreme interest to Dr. Francis Galton in his latest statistical compilations, for it contained no fewer than seven mathematicians of mark, distributed over three generations), but the main achievements are due to Euler, Lagrange and Laplace. In particular, the infinitesimal calculus in its various branches (including, that is to say, what we call the differential calculus, the integral calculus, and differential equations) received the development that now is familiar to all who have occasion to work in the subject. When this calculus was developed, it was applied to a variety of subjects; the applications, indeed, not merely influenced, but immediately directed, the development of the mathematics. To this period is due the construction of analytical mechanics at the hands of Euler, d'Alembert, Lagrange and Poisson; but the most significant achieve-

ment in this range of thought is the mathematical development of the Newtonian theory of gravitation applied to the whole universe. It was made, in the main, by Lagrange, as regards the wider theory, and by Laplace, as regards the amplitude of detailed application. But it was a century that also saw the obliteration of the ancient doctrines of caloric and phlogiston, through the discoveries of Rumford and Davy of the nature and relations of heat. The modern science of vibrations had its beginnings in the experiments of Chladni, and, as has already been stated, the undulatory theory of light was rehabilitated by the researches of Thomas Young. Strange views as to the physical constitution of the universe then were sent to the limbo of forgotten ignorance by the early discoveries of modern chemistry; and engineering assumed a systematic and scientific activity, the limits of which seem bounded only by the cumulative ingenuity of successive generations. But in thus attempting to summarize the progress of science in that period, I appear to be trespassing upon the domains of other sections; my steps had better be retraced so as to let us return to our own upper air. If I mention one more fact (and it will be a small one), it is because of its special connection with the work of this section. As you are aware, the elements of Euclid have long been the standard treatise of elementary geometry in Great Britain; and the Greek methods, in Robert Simson's edition, have been imposed upon candidates in examination after examination. But Euclid is on the verge of being disestablished; my own University of Cambridge, which has had its full share in maintaining the restriction to Euclid's methods, and which was not uninfluenced by the report of a committee of this association upon the subject, will, some six or seven weeks hence, hold its last examination in which those methods are prescriptively required. The disestablishment of Euclid from tyranny over the youthful student on the continent of Europe was effected before the end of the eighteenth century.

But it is time for me to pass on to the third of the centenaries, with which the present year can be associated. Not so fundamental for the initiation of modern science as was the year in which the 'Advancement of Learning' was published, not so romantic in the progress of modern science as was the year in which Halley gave his prediction to the world, the year 1805 (turbulent as it was with the strife of European politics) is marked by the silent voices of a couple of scientific records. In that year Laplace published the last progressive instalment of his great treatise on 'Celestial Mechanics,' the portion that still remained for the future being solely of an historical character; the great number of astronomical phenomena which he had been able to explain by his mathematical presentation of the consequences of the Newtonian theory would, by themselves, have been sufficient to give confidence in the validity of that theory. In that year also Monge published his treatise, classical and still to be read by all students of the subject, 'The Application of Algebra to Geometry'; it is the starting point of modern synthetic geometry, which has marched in ample development since his day. These are but landmarks in the history of mathematical science, one of them indicating the completed attainment of a tremendous task, the other of them initiating a new departure; both of them have their significance in the progress of their respective sciences.

When we contemplate the activity and the achievements of the century that has elapsed since the stages which have just been mentioned were attained in mathematical science, the amount, the variety, the

progressive diligence, are little less than bewildering. It is not merely the vast development of all the sciences that calls for remark: no less striking is their detailed development. Each branch of science now has an enormous array of workers, a development rendered more easily possible by the growing increase in the number of professional posts; and through the influence of these workers and their labors there is an ever-increasing body of scientific facts. Yet an aggregate of facts is not an explanatory theory any more necessarily than a pile of carefully fashioned stones is a cathedral; and the genius of a Kepler and a Newton is just as absolutely needed to evolve the comprehending theory as the genius of great architects was needed for the Gothic cathedrals of France and of England. Not infrequently it is difficult to make out what is the main line of progress in any one subject, let alone in a group of subjects; and though illumination comes from striking results that appeal, not merely to the professional workers, but also to unprofessional observers, this illumination is the exception rather than the rule. We can allow, and we should continue to allow, freedom of initiative in all directions. That freedom sometimes means isolation, and its undue exercise can lead to narrowness of view. In spite of the complex ramification of the sciences which it has fostered, it is a safer and a wiser spirit than that of uncongenial compulsion, which can be as dogmatic in matters scientific as it can be in matters theological. Owing to the varieties of mind, whether in individuals or in races, the progress of thought and the growth of knowledge are not ultimately governed by the wishes of any individual or the prejudices of any section of individuals. Here, a school of growing thought may be ignored; there, it may be denounced as of no importance; somewhere else, it may be politely persecuted out of possible existence. But the here, and the there, and the somewhere else do not make up the universe of human activity; and that school, like Galileo's earth in defiance of all dogmatic authority, still will move.

This complete freedom in the development of scientific thought, when the thought is applied to natural phenomena, is all the more necessary because of the ways of nature. Physical nature cares nothing for theories, nothing for calculations, nothing for difficulties, whatever their source; she will only give facts in answer to our questions, without reasons and without explanations; we may explain as we please and evolve laws as we like, without her help or her hindrance. If from our explanations and our laws we proceed to prediction, and if the event justifies the prediction through agreement with recorded fact, well and good: so far we have a working hypothesis. The significance of working hypotheses, in respect of their validity and their relation to causes, is a well-known battle-ground of dispute between different schools of philosophers; it need not detain us here and now. On the other hand, when we proceed from our explanations and our laws to a prediction, and the prediction in the end does not agree with the fact to be recorded, it is the prediction that has to give way. But the old facts remain and the new fact is added to them; and so facts grow until some working law can be extracted from them. This accumulation of facts is only one process in the solution of the universe: when the compelling genius is not at hand to transform knowledge into wisdom, useful work can still be done upon them by the construction of organized accounts which shall give a systematic exposition of the results, and shall place them as far as may be in relative significance.

Let me pass from these generalities, which have been suggested to my mind by the consideration of some of the scientific changes that have taken place during the last hundred years, and let me refer briefly to some of the changes and advances which appear to me to be most characteristic of that period. It is not that I am concerned with a selection of the most important researches of the period. Estimates of relative importance are often little more than half-concealed expressions of individual preferences or personal enthusiasms; and though each enthusiastic worker, if quite frank in expressing his opinion, would declare his own subject to be of supreme importance, he would agree to a compromise that the divergence between the different subjects is now so wide as to have destroyed any common measure of comparison. My concern is rather with changes, and with tendencies where these can be discerned.

The growth of astronomy has already occupied so large a share of my remarks that few more words can be spared here. Not less, but more, remarkable than the preceding centuries in the actual exploration of the heavens, which has been facilitated so much by the improvements in instruments and is reinforced to such effect by the cooperation of an ever-growing band of American astronomers, it has seen a new astronomy occupy regions undreamt of in the older days. New methods have supplemented the old; spectroscopy has developed a science of physics within astronomy; and the unastronomical brain reels at the contents of the photographic chart of the heavens which is now being constructed by international cooperation and will, when completed, attempt to map ten million stars (more or less) for the human eye.

Nor has the progress of physics, alike on the mathematical side and the experimental side, been less remarkable or more restricted than that of astronomy. The elaborate and occasionally fantastic theories of the eighteenth century, in such subjects as light, heat, even as to matter itself, were rejected in favor of simpler and more comprehensive theories. There was one stage when it seemed as if the mathematical physicists were gradually overtaking the experimental physicists; but the discoveries in electricity begun by Faraday left the mathematicians far behind. Much has been done towards the old duty, ever insistent, of explaining new phenomena; and the names of Maxwell, Weber, Neumann, and Hertz need only to be mentioned in order to suggest the progress that has been made in one subject alone. We need not hesitate to let our thoughts couple, with the great physicists of the century, the leaders of that brilliant band of workers upon the properties of matter who carry us on from wonder to wonder with the passage of each successive year.

Further, it has been an age when technical applications have marched at a marvelous pace. So great has been their growth that we are apt to forget their comparative youth; yet it was only the middle of the century which saw the awakening from what now might be regarded as the dark ages. Nor is the field of possible application nearing exhaustion: on the contrary, it seems to be increasing by reason of new discoveries in pure science that yet will find some beneficent outcome in practice. Invisible rays and wireless telegraphy may be cited as instances that are occupying present activities, not to speak of radium, the unfolding of whose future is watched by eager minds.

One gap, indeed, in this subject strikes me. There are great histories of mathematics and great histories of astronomy; I can find no history of physics on the grand scale. Some serviceable manuals there are,

as well as monographs on particular topics; what seems to me to be lacking is some comprehensive and comparative survey of the whole range. The history of any of the natural sciences, like the history of human activity, is not merely an encyclopædic record of past facts; it reveals both the spirit and the wealth which the past has bequeathed to the present, and which, in due course, the present will influence before transmission to the future. Perhaps all our physicists are too busy to spare the labor needed for the production of a comprehensive history; yet I cannot help thinking that such a contribution to the subject would be of great value, not to physicists alone.

But, as you hear me thus referring to astronomy and to physics, some of you may think of the old Roman proverb which made the cobbler not to look above his last; so I take the opportunity of referring very briefly to my own subject. One of the features of the century has been the continued development of mathematics. As a means of calculation the subject was developed as widely during the earlier portion of the century as during the preceding century; it soon began to show signs of emergence as an independent science, and the later part of the century has witnessed the emancipation of pure mathematics. It was pointed out, in connection with the growth of theoretical astronomy, that mathematics developed in the direction of its application to that subject. When the wonderful school of French physicists, composed of Monge, Carnot, Fourier, Poisson, Poinsot, Ampère and Fresnel (to mention only some names), together with Gauss, Kirchhoff and von Helmholtz in Germany, and Ivory, Green, Stokes, Maxwell and others in England, applied their mathematics to various branches of physics, for the most part its development was that of an ancillary subject. The result is the superb body of knowledge that may be summarized under the title of 'mathematical physics'; but the final interest is the interest of physics, though the construction has been the service of mathematics. Moreover, this tendency was deliberate, and was avowed in no uncertain tone. Thus Fourier could praise the utility of mathematics by declaring that 'there was no language more universal or simpler, more free from errors or obscurity, more worthy of expressing the unchanging relations of natural entities'; in a burst of enthusiasm he declares that, from the point of view he had indicated, 'mathematical analysis is as wide as nature herself,' and 'it increases and grows incessantly stronger amid all the changes and errors of the human mind.' Mathematicians might almost blush with conscious pleasure at such a laudation of their subject from such a quarter, though it errs by both excess and defect; but the exultation of spirit need not last long. The same authority, when officially expounding to the French Academy the work of Jacobi and of Abel upon elliptic functions, expressed his chilling opinion (it had nothing to do with the case) that 'the questions of natural philosophy, which have the mathematical study of all important phenomena for their aim, are also a worthy and principal subject for the meditations of geometers. It is to be desired that those persons who are best fitted to improve the science of calculation should direct their labors to these important applications.' Abel was soon to pass beyond the range of admonition; but Jacobi, in a private letter to Legendre, protested that the scope of the science was not to be limited to the explanation of natural phenomena. I have not quoted these extracts by way of even hint of reproach against the author of such a wonderful creation as Fourier's analytical theory

of heat; his estimate could have been justified on a merely historical review of the circumstances of his own time and of past times; and I am not sure that his estimate has not its exponents at the present day. But all history shows that new discoveries and new methods can spread to issues wider than those of their origins, and that it is almost a duty of human intelligence to recognize this possibility in the domain of progressive studies. The fact is that mathematical physics and pure mathematics have given much to each other in the past and will give much to each other in the future; in doing so, they will take harmonized action in furthering the progress of knowledge. But neither science must pretend to absorb the activity of the other. It is almost an irony of circumstance that a theorem, initiated by Fourier in the treatise just mentioned, has given rise to a vast amount of discussion and attention, which, while of supreme value in the development of one branch of pure mathematics, have hitherto offered little, if anything, by way of added explanation of natural phenomena.

The century that has gone has witnessed a wonderful development of pure mathematics. The bead-roll of names in that science—Gauss; Abel, Jacobi; Cauchy, Riemann, Weierstrass, Hermite; Cayley, Sylvester; Lobatchewsky, Lie—will on only the merest recollection of the work with which their names are associated show that an age has been reached where the development of human thought is deemed as worthy a scientific occupation of the human mind as the most profound study of the phenomena of the material universe.

The last feature of the century that will be mentioned has been the increase in the number of subjects, apparently dissimilar from one another, which are now being made to use mathematics to some extent. Perhaps the most surprising is the application of mathematics to the domain of pure thought; this was effected by George Boole in his treatise 'Laws of Thought,' published in 1854; and though the developments have passed considerably beyond Boole's researches, his work is one of those classics that mark a new départure. Political economy, on the initiative of Cournot and Jevons, has begun to employ symbols and to develop the graphical methods; but there the present use seems to be one of suggestive record and expression, rather than of positive construction. Chemistry, in a modern spirit, is stretching out into mathematical theories; Willard Gibbs, in his memoir on the equilibrium of chemical systems, has led the way; and, though his way is a path which chemists find strewn with the thorns of analysis, his work has rendered, incidentally, a real service in coordinating experimental results belonging to physics and to chemistry. A new and generalized theory of statistics is being constructed; and a school has grown up which is applying them to biological phenomena. Its activity, however, has not yet met with the sympathetic good-will of all the pure biologists; and those who remember the quality of the discussion that took place last year at Cambridge between the biometricians and some of the biologists will agree that, if the new school should languish, it will not be for want of the tonic of criticism.

If I have dealt with the past history of some of the sciences with which our section is concerned, and have chosen particular epochs in that history with the aim of concentrating your attention upon them, you will hardly expect me to plunge into the future. Being neither a prophet nor the son of a prophet, not being possessed of the knowledge which enabled Halley to don the prophet's mantle with confidence, I shall

venture upon no prophecy even so cautious as Bacon's—'As for the mixed mathematics, I may only make this prediction, that there can not fail to be more kinds of them as nature grows further disclosed'—a declaration that is sage enough, though a trifle lacking in precision. Prophecy, unless based upon confident knowledge, has passed out of vogue, except perhaps in controversial politics; even in that domain, it is helpless to secure its own fulfilment. Let me rather exercise the privilege of one who is not entirely unfamiliar with the practice of geometry, and let me draw the proverbial line before indulgence in prophetic estimates. The names that have flitted through my remarks, the discoveries and the places associated with those names, definitely indicate that, notwithstanding all appearance of divergence and in spite of scattered isolation, the sum of human knowledge, which is an inheritance common to us all, grows silently, sometimes slowly, yet (as we hope) safely and surely, through the ages. You who are in South Africa have made an honorable and an honored contribution to that growing knowledge, conspicuously in your astronomy and through a brilliant succession of astronomers. Here, not as an individual, but as a representative officer of our brotherhood in the British Association, I can offer you no better wish than that you may produce some men of genius and a multitude of able workers who, by their researches in our sciences, may add to the fame of your country and will contribute to the intellectual progress of the world.

A. R. Forsyth.

SCIENTIFIC BOOKS.

Catalogue of the Lepidoptera Phalænæ in the British Museum, London. Vol. IV., Noctuidæ (part), 1903; Vol. V., Noctuidæ (continued), 1905. By Sir George F. Hampson, Bart.

This is a continuation of the monographs of the moths of the world, of which Vol. III. was noticed in Science, N. S., XV., 99, 1901. A notice of Vol. IV. will be found in the *Canadian Entomologist,* XXXVI., 27, 1904. Volume V., now before us, consists of 634 pages and treats of 2,073 species of Noctuidæ, comprising the subfamily Hadeninæ. These moths have unspined hind tibiæ and hairy eyes, and are familiar to us under the name *Mamestra* and allies. But these familiar names are again largely changed, unavoidably, no doubt, but we fear that the changes are not permanent. Even if subsequent authors can be induced to respect Sir George Hampson's selections of the types of the older genera, we doubt if he will be generally followed in defining no genera on secondary sexual characters. This is done generally in other families of Lepidoptera and the characters prove very useful. We think some of the genera as used in the volume before us would stand subdivision, *Polia,* for example, which contains 209 species. This would save the old genus *Mamestra,* which now sinks as a synonym of *Polia.* These remarks apply to the other volumes as well and are a criticism on the general system adopted. It is not to be expected that the system could be changed during the progress of the work.

A number of our North American species, particularly those recently described, sink as synonyms. This is mostly perfectly justified, as there has been a tendency recently to describe too many forms as species in the Noctuidæ. This tendency has received a just rebuke.

On page 24, *Scotogramma* is marked as a 'new' genus, no doubt by an oversight.

On page 178 all the forms of *comis* and *olivacea* fall together into the synonymy. I believe this is going a little too far, as I think there can be distinguished two species, though closely allied. Otherwise my contention about these forms is sustained.

On page 267 the name *Chabuata velutina* is used. It should be *Chabuata lutina. Velutina* was preoccupied when described and the author very properly changed the name. The

fact that Hampson has removed it to another genus does not invalidate the change, which was proper when made. He has here violated the rule 'Once a synonym, always a synonym.'

Page 366. The distribution of the genus *Morrisonia* is remarkable. Twenty-eight species are known, twenty-two in New Zealand, six in the United States, and none anywhere else in the world. Of the United States species, five are eastern, only one being western (Arizona). Morrison's species *peracuta*, described as from the United States, is removed to the next genus and becomes a synonym of a New Zealand species, the United States locality being regarded as erroneous.

Page 403, my species *Perigrapha achsha* is omitted (*Can. Ent.*, XXXVI., 32, 1904).

On page 596, *Leucania rubripallens* is credited to Kaslo, British Columbia. I did not find the species there (*Proc. U. S. Nat. Mus.*, XXVII., 863, 1894), and I believe that this is a case of misidentification. The synoptic table on page 594 is bad, the contrasts given under a^2 and b^2 are variable and valueless. *L. rubripallens* separates from *oxygale* and *minorata* by the redder color of the fore wings only, not by the degree of black shading on the hind wings. It occurs in the dry regions of Colorado and Utah and I believe does not occur in the wet wooded district of Kaslo.

On page 610, *Himella infidelis* is made synonymous with *Eriopyga conar* and marked 'non descr.' I do not object to the synonym, even if I do not agree to it, but the species certainly was described (*Can Ent.*, XXXVI., 32, 1904).

HARRISON G. DYAR.

SCIENTIFIC JOURNALS AND ARTICLES.

THE leading article in the June number of the *American Geologist* is entitled 'The Fossil Turtles of the Bridger Basin,' by O. P. Hay, who states that hitherto geologists Cope, Powell, Emerson and King considered these beds as lake deposits, but his own conclusion is that they have 'been made almost wholly through river action.' Professor S. W. Williston says, concluding his article 'On the Lansing Man,' 'I am only confident that the skeleton dates from Pleistocene times—and is old.' Professor Warren Upham contributes an article on the 'Age of the St. Croix Dalles,' and G. A. Waring one on 'The Pegmatyte Veins of Pala, San Diego County, California,' which is illustrated by five plates and two figures. Professor J. A. Bownocker in discussing 'The Salt Deposits of Northeastern Ohio,' concludes 'that Ohio contains enough salt to supply the entire country for an indefinite period.' A paper on 'Mineralogical Synonyms' is inserted, taken from the *Mineralogical Magazine* for May. The number concludes with an interesting editorial by Dr. G. P. Merrill on 'The New Building for the National Museum, at Washington, D. C.,' which is illustrated by a plate presenting the central plan.

SOCIETIES AND ACADEMIES.

CLEMSON COLLEGE SCIENCE CLUB.

THE 54th regular meeting of the club was held in the lecture room of the electrical laboratory, April 28, at 8 P.M. It was the occasion of the ninth annual meeting and banquet. There were present, in addition to the regular members of the club, delegates from other colleges in South Carolina and from the U. S. Department of Agriculture. The program consisted of numbers taken from the preceding programs of the club during the current year, and an informal address on certain phases of agricultural education by Assistant Secretary of Agriculture W. H. Hays. After the regular meeting, the annual banquet was served in the new museum in agricultural hall, and the banquet was made the occasion of the dedication of the museum.

The 55th regular meeting of the club was held in the lecture room of the electrical laboratory at 8:30 P.M., May 19. Professor J. S. Newman, under the title of 'Fifty Years of Agriculture,' discussed the advances in practical agriculture within that time, taking a somewhat pessimistic attitude in regard to what had actually been accomplshed. Professor F. T. Dargan, under the title of 'An Undescribed Method of Demonstrating Horizontal Objects,' made a demonstration of his

apparatus and method, exhibiting Ewing's experiment for demonstrating Weber's molecular theory of magnetism, and showing the magnetic field by use of iron filings. The apparatus, which was very simple, is described as follows: The object to be exhibited is placed on a base (which in the speaker's apparatus consisted of a 60 by 75 centimeter drawing-board covered with white paper). Against two nails driven into this base near the back a large plane mirror is placed, and inclined forward at any desired angle by means of a wire attached to the top of the mirror and passing through a binding post screwed into the back of the base. To each upper corner of the mirror is clamped a 50-candle-power General Electrical Company 'stereopticon' lamp protected in front by metal half shades. These brilliantly illuminate the object and obviate shadows. The apparatus can, of course, be made permanent by hinging the mirror to the base and fastening the lights permanently. It will be seen that the apparatus has many applications in the teaching of the biological as well as physical sciences in exhibiting objects that can not be turned on their edge. The apparatus has the advantage over the projecting lantern with horizontal attachment, first that it does not require a darkened room; second, opaque objects can be exhibited; third, the size of the object to be exhibited is limited only by the size of the mirror; fourth, the apparatus is not only easy to operate, but can be put together from materials usually found in any laboratory.

At the close of the regular meeting, the annual business meeting was held. The annual report of the secretary was received. The following officers were elected for the ensuing year:

President—Professor F. S. Shiver.

Vice-President—Professor S. W. Reaves.

Secretary—Dr. F. H. H. Calhoun.

Members of Council—Dr. J. H. James and Professor F. T. Dargan.

HAVEN METCALF,
Secretary.

SPECIAL ARTICLES.

ASSORTATIVE MATING IN MAN.

As was pointed out in *Biometrika,* Vol. II., No. 4, 1903, "Darwin has given the name of sexual selection to the general conception of differential mating. As opposed to pure random mating within the population, we have first *preferential* mating, in which male or female classes with certain values of a character find it less easy to mate than other classes with different values. Secondly, we have *assortative mating,* in which, while all classes of males and females find mates, certain classes of males appear to be attracted to certain classes of females. If the male class of a given character tends to mate with a female class with generally like character we have a tendency to *homogamy.* Homogamy as one type of assortative mating is simply measured by the correlation between the two characters in the male and female of the pair. The influence of homogamy on the character of successive generations of a population may be very great indeed, and the whole range of effect from pure random matings to perfectly homogamous unions within a population is almost but not quite as important as the difference between self and cross fertilization in plants. It has the distinctive features as compared with self fertilization, that (1) it may have any degree of intensity, (2) it may be confined to special characters, and (3) it is not complicated by any of the supposed harmful effects of inbreeding."

In the paper from which the paragraph I have just quoted was taken we dealt with assortative mating in man with respect to a character—longevity—concerning which there could not possibly be any *conscious* selection. The characters dealt with by Pearson in former papers[1] are also—at least, probably—not made the object of conscious selection. The coefficients of correlation between man and wife in all these cases average about .2—or 'husband and wife are as much alike as uncle and niece, and probably as much alike as, if not more alike than, first cousins.'

[1] *Phil. Trans.*, Vol. 187, A, p. 273, and Vol. 195, A, p. 113; *Biometrika*, II., p. 353.

It seemed to me to be of interest, now, to test the strength of assortative mating with respect to a character in which there is known to be *conscious* selection. The ages of the two members of the pair at once suggested itself. It possesses an added interest because of the former work upon the age at death. I accordingly tabulated the ages of twenty-five hundred couples as given at the marriage license office at Chicago during the spring of 1904. Grouped in three-year classes they are as shown in table.

The data are a little unsatisfactory because of the unfortunate but undeniable proneness of humanity to a lapse of honesty in the matter of age, especially in this connection.

TABLE OF AGE AT MARRIAGE.

WIFE.

Husband.	13–15	16–18	19–21	22–24	25–27	28–30	31–33	34–36	37–39	40–42	43–45	46–48	49–51	52–54	55–57	58–60	
16–18		2															2
19–21	1	113	147	25	5	3											294
22–24		76	334	169	32	4	4	1									620
25–27		59	217	197	101	20	3	1	1								599
28–30		14	74	117	100	52	16	3	4	2							382
31–33		3	21	35	48	34	20	7	4	4							176
34–36		2	13	26	29	23	21	11	3	5	4		1	1			139
37–39		1	2	12	16	15	9	8	15		6	3	1	1			89
40–42		1	3	7	10	8	4	9	10	8	1		2				63
43–45				4	2	5	6	6	6	5	6	2		1			43
46–48				1	3	3	3	2	4	5	3	2	2				28
49–51				2	1	2		4	1	3	2	4	4	2	1		26
52–54			1			3	1	2	1	2	3	4	1	1	1		20
55–57										2	2		1		2		7
58–60				2						2		1	1	1	1	2	10
61–63														1			1
64–66															1		1
	1	271	812	597	347	172	87	54	49	38	27	16	13	8	6	2	2500

So that the figures, instead of telling the exact truth, show us the state of things, modified somewhat by man's ideas of how he thinks they had better be. This undoubtedly raises the coefficient of correlation slightly. It possibly also accounts for some of the extreme skewness of the curve for the wife's age.

However that may be, the coefficient of correlation between the ages of man and wife, as given, is .764. If this be compared with that of stature (.280), span (.199), forearm (.198) or longevity (.223), it will make it possible to appreciate more clearly the precise extent of the unconscious assortative mating.

The writer has on hand data which show that this principle applies to certain insects and spiders as well as to man. So that we are doubtless dealing here with a real biological factor as well as one of sociological interest.

FRANK E. LUTZ.
STATION FOR EXPERIMENTAL EVOLUTION,
COLD SPRING HARBOR, N. Y.

CURRENT NOTES ON METEOROLOGY.

PROGRESS OF KITE AND BALLOON METEOROLOGY.

A FEW years ago no one would have foreseen that a regular publication would be started in 1904, devoted to the physics of the free air, and even to-day scientific men generally must be surprised to see the quantity and the quality of the contributions which deal with the meteorological conditions of the free air. A recent number of the *Beiträge zur Physik der freien Atmosphäre* (No. 3, 1905), besides the paper on cyclonic and anticyclonic temperatures by Clayton, mention of which was recently made in these notes, contains a study of the results obtained during synchronous kite flights from Berlin and Hald (Jutland) from the summer of 1902 to the spring of 1903, and also a short note, by Professor Hergesell, on recent observations on the meteorological conditions of the high warm stratum of air which was first noticed

by Assmann and Teisserenc de Bort at an altitude of about 11 kms. Recent observations during a *ballon-sonde* flight from Strassburg (February 9, 1905) prove the existence of an easterly current at great altitudes, which is independent of the lower currents. The temperature conditions of this upper air stratum show that vertical currents are practically absent, and its high relative humidity suggests some interesting speculations as to its origin.

METEOROLOGICAL ACTIVITY IN ENGLAND.

The Council of the Royal Meteorological Society of England is about to undertake an extended campaign with a view to advancing the general knowledge of meteorology. A series of lectures is planned, to be of a practical nature, usually illustrated by lantern slides, and to be given by lecturers, appointed by the council, at different places. When possible, exhibits of meteorological instruments are to be made, especially at the shows of the various agricultural societies. The authorities in charge of the 'Agricultural Education in Elementary Schools Bill,' now before Parliament, have been approached with a view to the inclusion of meteorology among the subjects taught in such schools. The scheme as a whole provides for bringing meteorological knowledge to the doors of societies and institutions all over Great Britain. It is also proposed to hold conferences in London, at which delegates from various societies shall be invited to speak. The whole plan shows a healthy activity on the part of the Royal Meteorological Society.

TROPICAL CYCLONES.

The cyclones of the tropics are of universal interest because of their violence; they are of peculiar interest to meteorologists because of their importance as phenomena having the closest relations to human life and safety, and because of the doubt as to their origin, which gives them an added attraction in the mind of the student. One of the noteworthy efforts to come to a fuller understanding of the frequency, tracks and wind movements in tropical cyclones is a recent paper by A. Schück, of Hamburg, entitled 'Zur Kenntniss der Wirbelstürme' (Hamburg, 1905, 4to, pp. 48). This account is accompanied by a large number of illustrations, including some most interesting pressure curves, although the diagrams are crudely drawn and rather difficult to make out.

CLIMATIC CHANGES IN CENTRAL AFRICA.

A good deal of evidence has been adduced within the last two or three years regarding a desiccation of the lakes of central Africa, and the view has come to be somewhat generally held that a distinct change to a drier climate is in progress. Now comes the report (*Globus*, No. 5, 1905) that Lake Rukwa, to the east of Lake Tanganyika, has risen within two years. Such contradictory reports show the need of great caution in jumping at conclusions of climatic change. Periodic changes in the amount of annual rainfall are well known, but they do not indicate permanent climatic changes progressively in one direction.

COTTON-GROWING IN TROPICAL AUSTRALIA.

The evolution of a marketable type of cotton which has been named *caravonica*, adapted for growth in the climate of Queensland, holds out the hope of a large cultivation of cotton not only in Queensland, but through the whole of the tropical section of Australia north of latitude 18° S. (*Bull. Amer. Geogr. Soc.*, XXXVII., No. 4, 1905).

HURRICANES, COCOA TREES AND EXPORTS OF GUAM.

A recent report, 'Contributions from the United States National Herbarium,' Vol. IX., by W. E. Safford, under the special title, 'The Useful Plants of Guam,' notes the damage done by hurricanes which pass near the island of Guam. In 1900, the destruction caused by two hurricanes resulted in a dearth of food, and nearly $10,000 was spent by the government for the relief of the natives. One of the most serious results is the stripping of cocoa trees of their leaves, which may cause a failure of the trees to produce. In 1901, after the hurricanes above noted, not an ounce of copra was produced in Guam, this being practically the only export of the island.

EXPOSURE AND CROPS IN SWITZERLAND.

NUMBERLESS examples may be given to show the difference of exposure, on southern and northern slopes, upon the vegetation. A recent striking illustration is noted in *La Géographie*, No. 3, 1905, and described in the *Bulletin of the American Geographical Society* for July. Above the hamlet of Findelen, near Zermatt, in the Alps, barley and rye are grown at an altitude of 6,900 feet above sea level, on a sunny southern slope. On the northern slopes, a few hundred yards distant, there is an arctic-alpine flora, with patches of snow lying below the level of the fields of grain on the southern slope.

R. DEC. WARD.

ACTA OF THE INTERNATIONAL CONVENTION OF THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

OPENING meeting: Tuesday, July 25, at 11 A.M., at the rooms of the Royal Society.

1. Professor Darboux moved that Professor H. E. Armstrong be the chairman of the convention. The motion having been carried unanimously, Professor H. E. Armstrong took the chair and welcomed the delegates.

2. On motion of the chairman, at the request of the Royal Society, Mr. A. B. Kempe, treasurer of the Royal Society, and Dr. L. Mond, member of the executive committee, were invited to take part in the deliberations of the convention.

3. On the motion of the chairman it was resolved: That Dr. J. Deniker be the secretary for the French language; Professor Dr. August von Böhm, secretary for the German language; Cav. E. Mancini, secretary for the Italian language, and Dr. H. Forster Morley, secretary for the English language.

4. On the motion of the chairman, seconded by Dr. Stejneger, it was resolved: That, in view of the success already achieved by the International Catalogue of Scientific Literature and of its great importance to scientific workers, it is imperative to continue the publication of the catalogue at least for a further period of five years.

5. On the motion of the chairman, seconded by M. Darboux, it was resolved that Dr. H. Forster Morley be reappointed director of the catalogue at a salary of £500 per annum.

6. On the motion of the chairman, seconded by Dr. Deniker, it was resolved: That the convention authorizes the annual expenditure of a sum not exceeding £2,000 (in addition to the director's salary), for carrying on the work of the Central Bureau.

Second meeting: Wednesday, July 26, at 10 A.M., at the rooms of the Royal Society.

7. On the motion of M. Darboux it was resolved: That in view of the resolution arrived at to continue the catalogue for a further period of five years, the Royal Society of London be requested: (*a*) Again to act as the publishing body; (*b*) to conclude a contract with Messrs. Harrison and Sons to print the catalogue on the terms indicated in the report of the executive committee; (*c*) to make such provision of working capital as may be desirable in the opinion of the executive committee.

8. On the motion of Dr. Larmor it was unanimously resolved: That as it is undesirable to increase the borrowed capital of the International Catalogue, contracting bodies be informed that in cases where payment in advance is impracticable it is necessary that payment should be made for each volume as soon as possible after delivery. That the director be instructed, in making such special requests for payment as the executive committee may determine, to send a copy of this resolution with his request.

9. On the motion of the chairman it was resolved: That the convention approves of the proposal for an amalgamation of the *Zoological Record* published by the Zoological Society of London with Volume N of the International Catalogue in accordance with paragraph 24 of the report, and authorizes the executive committee to carry the proposal into effect.

10. On the motion of Dr. Stejneger it was resolved: That it is the desire of this convention that the executive committee, as soon as practicable, take into consideration the question of issuing cards.

11. On the motion of Dr. Stejneger, seconded by Dr. Deniker, it was resolved: That

the reports of the committee of schedules be adopted.

12. On the motion of the chairman it was resolved: That the report of the executive committee be adopted and that all matters therein not dealt with by this convention be remitted to the executive committee with power to act thereon.

13. On the motion of Professor Korteweg, seconded by Dr. Deniker, it was resolved that thanks be given to Professor Armstrong for presiding over the convention.

Henry E. Armstrong,	D. G. Métaxas,
Oskar Uhlworm,	J. Deniker.
D. J. Korteweg,	D. Prain,
August v. Böhm,	R. Nasini,
Leonhard Stejneger,	Ernesto Mancini,
I. Borodin,	K. Matsubara,
Roland Trimen,	G. Darboux,
Paul Otlet,	Francisco A. de Icaza,
H. La Fontaine,	J. Larmor.

SCIENTIFIC NOTES AND NEWS.

Major Ronald Ross and Dr. Rubert Boyce, of the Liverpool School of Tropical Medicine, have arrived in this country to cooperate with the authorities at New Orleans in suppressing the epidemic of yellow fever.

Sir Patrick Manson, medical adviser to the English colonial office, arrived at San Francisco on August 14 to deliver a course of lectures on tropical diseases at the Lane Hospital.

Professor John M. Coulter and Dr. H. C. Cowles have leave of absence from the University of Chicago, and expect to spend the autumn and winter in Europe, returning to the university in April. Professor Charles R. Barnes, who has been spending six months in Europe, will return to Chicago for the autumn quarter.

Dr. Oliver L. Fassig, of the U. S. Weather Bureau and the Johns Hopkins University, has returned to this country from his Arctic voyage in search of Captain Fiala.

Dr. W. Wyssling, professor of electrical engineering in the Zurich Polytechnicum, was expected to arrive in New York this week to study developments of electrical engineering.

Mr. Jesse M. Greenman, of Harvard University, has been appointed assistant curator of the Department of Botany of the Field Columbian Museum.

Dr. R. von Wettstein, professor of botany at the University of Vienna, has been elected a member of the Academy of Sciences at Madrid.

We learn from *The British Medical Journal* that Dr. Paul Richer, member of the French Académie de Médecine, and one of the editors of the *Iconographic de la Salpêtrière,* has been elected a member of the Paris Academy of Fine Arts. Dr. Richer is professor of anatomy at the Ecole des Beaux Arts, but he owes the honor which has been conferred upon him to his distinction as a sculptor.

The *Pharmaceutical Journal* says that the research fellowship in chemistry offered by the Company of Salters, and tenable in the research laboratory of the Pharmaceutical Society, has this year been awarded to Miss Nora Renouf, who has been engaged in original investigations for the past two years in the society's laboratories as holder of the Redwood and the Burroughs scholarships.

Nature states that the editorship of the 'Fauna of British India,' rendered vacant by the death of Dr. W. T. Blanford, has been offered by the secretary of state for India to Lieut.-Colonel C. T. Bingham.

A memorial window has been placed in St. John's in the Wilderness, Paul Smith's, in the Adirondacks, in memory of the late Dr. Edward L. Trudeau, Jr.

Dr. Louis H. Laudy, tutor in general chemistry in Columbia University, died in New York on August 17. Dr. Laudy was a fellow of the American Association for the Advancement of Science and of the New York Academy of Sciences.

Dr. Lyman Hall, president of the Georgia School of Technology, Atlanta, died on August 17 at the age of forty-five years. He was a graduate of the West Point Military Academy and became professor of mathematics in the Georgia School of Technology in 1888.

M. Bichat, professor of physics and dean of the faculty at Nancy, died on July 26, at the age of sixty years. He was a correspondent of the Paris Academy of Sciences, and a member of the council of public instruction.

Mr. Christopher Heath, a well-known British surgeon, emeritus professor of clinical surgery in University College, London, died on August 8, at the age of seventy years.

Professor L. Errera, who held the chair of botany at the University of Brussels, died on August 1.

It is reported in the daily papers that a seventh satellite of Jupiter has been observed at the Lick Observatory.

The first telegraphic longitude station in Labrador has been established at Chateau Bay by Dr. Otto Klotz, Dominion astronomer, in conjunction with Sir William Macgregor, governor of Newfoundland.

The International Congress of Anatomy was opened at Geneva, on August 7, in the presence of 300 representatives of the principal universities of Europe and America. Dr. Eternod, of Geneva, delivered the opening speech. The meeting then entered upon the business to be dealt with, under the presidency of Mr. Symington, of Belfast. The congress has accepted the invitation to assemble at Boston in 1907.

The seventh meeting of the International Congress of Hydrology, Climatology, Geology and Physical Therapeutics will be opened at Venice on October 10 under the honorary presidency of the Italian Minister of Public Instruction, and the acting presidency of Professor A. De Giovanni, of the University of Padua, senator of Italy.

The International Earthquake Conference met at Berlin on August 15. Dr. Theodor Lewald, who was the German commissioner general to the St. Louis Exposition, was elected chairman.

The Latin American Scientific Congress was opened on August 8, delegates from all the South American Republics being present.

The ninth Northern Congress of Schoolmasters was opened in the town-hall at Copenhagen, on August 10. There were present about 7,000 schoolmasters, teachers, instructors and professors, Denmark sending 3,500, Sweden over 2,000, Norway 1,000, and Finland nearly 400. Teachers of every kind are represented, from the poorest village schoolmasters to university professors.

The membership enrolment of the National Educational Association at the forty-fourth annual meeting, held at Asbury Park, from July 3 to 7, is officially reported to be 20,941.

We learn from *The Botanical Gazette* that a new botanical institute, well arranged for research and instruction, has recently been completed for Professor R. Wettstein in the Imperial Botanical Gardens in Vienna.

The *British Medical Journal* states that a medical group has recently been formed in the Italian Parliament. The members are Drs. Agnetti, Angiolini, Baccelli, Badaloni, Basetti, Botteri, Cacciapuoti, Campi, Cantarano, Casciani, Castellino, Ciartoso, Faranda, Fazzi, Fede, Gatti, Lampiasi, Licata, Maresca, Masini, Masselli, Pianese, Queirolo, Rampoldi, Rummo, Sanarelli, Santini, Santoliquido, Scellingo and Tinozzi. The new group, which recently held its first meeting, will direct its efforts to influencing all legislation relating to public health and the legitimate interests of the medical profession. Under the auspices of the group, a general congress of the medical practitioners, poor-law medical officers, pharmacists and veterinarians of Italy, to discuss questions affecting professional interests, will be held in Rome in November.

The *Annales de l'Institut Pasteur* state that the number of persons treated for hydrophobia in Paris during the year 1904 was 755, of whom three died, the rate of mortality being .39 per cent. For the last ten years the rate of mortality has ranged from .18 per cent. in 1902 to .39 per cent. in 1897 and 1904. The department of the Seine (Paris) furnished the largest contingent (233) of persons bitten, the departments which came next in order being the Finistère (50), the Corrèze (28), the Vendée (27), the Loire Inférieure (26), the Lot (25), the Cher and the Deux Sèvres (21).

The final results of the Russian census of 1897 are still appearing at intervals. Among

the latest figures published by the Statistical Department are the following: The total population of the Russian empire (excluding Finland), on May 10, 1897, was 126,586,525. Of these 87,123,604 were members of the Orthodox Church. Old Believers and other sections number 2,204,596; Mahomedans, 13,906,972; Roman Catholics, 11,467,994; Jews, 5,215,805; Protestants (Lutherans), 3,572,653. A division of the population on the basis of classes gives the following results: Hereditary nobles, 1,220,169; nobles for life, or by virtue of office, 630,119; priests of all Christian denominations, 588,947; honorable citizens, 342,927; merchants, 281,179; burgesses, 13,386,392; peasants, 96,896,648; Cossacks, 2,928,842; foreigners, 8,297,965 (this figure includes considerable numbers of the subject population). Illiterates numbered 99,070,436 (79 per cent.); literates, 26,569,585. Students at the universities and other institutions for higher education numbered 104,321.

According to a report, made by Dr. E. O. Hovey, for the U. S. Geological Survey, the production of salt in the United States during 1904 was 22,030,002 barrels (of 280 pounds), valued at $6,021,222, as compared with 18,968,089 barrels, valued at $5,286,988 in 1903. This is the largest production ever reported except in 1902, but the average net price per barrel (27.332 cents) is lower than that reported in 1903 (27.873 cents) or in any previous year, with the exception of 1902, when the average net price realized was only 23.769 cents a barrel. The most noteworthy feature of the year 1904 was the increase of 1,193,620 barrels in the production of rock salt. This increase was due in large part to the expansion of the salt industry of Louisiana, where rock salt is easily and cheaply mined in the 'mounds' which occur in the southern part of the state. The chief salt-producing States are New York and Michigan, and the combined output from these two States amounts to about two-thirds of the total production of the United States. The five leading salt-producing states during 1904 were New York, 8,600,656 barrels (39.04 per cent.); Michigan, 5,425,904 barrels (24.63 per cent.); Ohio, 2,455,829 barrels (11.15 per cent.); Kansas, 2,161,819 barrels (9.81 per cent.), and Louisiana, 1,095,850 barrels (4.97 per cent.). The actual consumption of salt in 1904 was 23,116,971 barrels, or about 2.46 times what it was in 1880. The imports of salt in 1904 amounted to 332,279,481 pounds. Great Britain contributed 98,943,611 pounds, worth $301,-696; Italy 106,060,288 pounds, valued at $75,-756; Canada 11,102,273 pounds, valued at $27,-529; West Indies 105,160,371 pounds, worth $89,878; and other countries 20,882,959 pounds, valued at $20,371. The total value of all the imported salt was thus $515,230. It will be observed that while the value of the salt imported from Great Britain was more than 58.5 per cent. of the total value of imports for the year, the quantity received from that country was only about 28.9 per cent. of the total amount of salt imported. The West Indies and Italy both exceeded Great Britain in the quantity of salt exported to the United States, but it was all of coarse grades, and consequently of low valuation.

A press bulletin of the Forest Service says that the annual value of the staves, hoops and heads made by the mills of the United States is over $20,000,000. It is estimated that more than 300,000 barrels, kegs, tubs and similar articles are manufactured daily in the United States. Until a very recent date the woods chiefly used for cooperage were the slow-growing hardwoods such as oak, elm, maple, ash, beech and birch, but within the last few years cottonwood, poplar, and latterly gum, have been substituted to some extent, owing to the diminishing supply of the species first exploited. The depletion of the supply of raw material is felt strongly by the manufacturer, who finds it yearly more difficult to obtain good stock. This is especially true for white oak, since the maker of tight cooperage must often refuse stock which a furniture maker would consider first-class material. Two factors have contributed to bring about this condition—first, the increase in the cooperage manufacture, which has developed enormously in the past quarter century; and, second, the extremely wasteful methods employed in cutting, which have left the forest in a deplorable condition, and often wasted more material than

was used. Cutting for cooperage purposes is far more wasteful than is ordinary lumbering. The Forest Service in taking up this question aims to make its investigations of practical value to the cooperage industry and its operators. It is planned to bring together information regarding the supply of raw material, and the best methods of manufacture, and the ill effects of wasteful methods on the forest and possible remedies for them. Particular attention will also be given to a study of the properties of woods, with the view of recommending substitutes which are more abundant than the species now used for cooperage.

A Parliamentary paper has been issued containing the report of his majesty's astronomer at the Cape of Good Hope to the secretary of the admiralty for the year 1904. According to an abstract in the London *Times* the report makes a sympathetic reference to the death of Mr. Frank McClean, to whose generosity the observatory owes the Victoria telescope, with its observatory, dome and many valuable adjuncts. After referring to the work in connection with the new transit circle and the new sidereal clock, the report states that owing to an unfortunate accident, which occurred during the absence of the regular observers, the driving worm and sector of the Victoria telescope were damaged, and the moving portion of the instrument, including the Polar axis and telescope tubes, had to be raised in order to remove the damaged sector. The driving worm of the sector and slow-motion gear were sent to Sir Howard Grubb for alteration and repair early in November. Sir Howard Grubb promised to send off the repaired sector by the end of January, together with an electromotor giving 'quick slow motion' in R.A., a much-needed adjunct for facilitating the placing of the image of the star on the slit. In consequence of this accident the new objective prism had not yet been tested. Details of astronomical observations are given, and the report says that the astronomer has, at the request of the Colonial governments, generally superintended the geodetic survey of South Africa and taken a prominent part in the preparation of arrangements for the establishment of a central office to complete the geodetic and topographic survey of British South Africa south of the Zambesi. The negotiations for that purpose are now nearly completed, and the whole will be placed under the charge of Colonel Morris, whose name has so long and so honorably been connected with the survey of South Africa. Though the admiralty is not connected with this important work, details of the proceedings of the past year are included in this report, as no other record of its progress is issued.

UNIVERSITY AND EDUCATIONAL NEWS.

Dr. Eli McClish has resigned the presidency of the University of the Pacific.

Mr. C. M. Jansky, of the Bureau of Standards, formerly of the University of Michigan, has been appointed professor of electrical engineering at the University of Oklahoma.

Mr. Albert S. Ritchey, of Indianapolis, Ind., has been appointed assistant professor of railroad engineering at the Worcester Polytechnic Institute.

Dr. J. E. Ives, of the De Forest Wireless Telegraph Company, has been appointed assistant professor of physics in the University of Cincinnati.

Dr. W. M. Twitchell has been appointed professor of geology in South Carolina College.

The Psychological Bulletin states that Dr. Williston S. Hough, formerly of the University of Minnesota, has been appointed professor of philosophy in George Washington University.

Dr. Thomas W. Mitchell, instructor in accounting and finance in the University of Pennsylvania, has been appointed assistant professor of finance and accounts in the School of Commerce in New York University to succeed Professor Henry W. Mussey, who goes to Bryn Mawr College.

Mr. George F. Lamb has been appointed professor of biology in Mt. Union College, Ohio.

Dr. Wilhelm Deeke has been promoted to a chair of mineralogy at Griefswald.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, SEPTEMBER 1, 1905.

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

ADDRESS BY THE PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.[1]

II.

AT Cape Town I attempted to make a general survey of evolution in its various branches, and laid down certain general propositions as to what seems common to all of them.

I then went on to consider how these general laws found an application in the most recent speculations as to the constitution of matter. The atoms of the elements and the molecules of chemical combinations are constructed on so minute a scale that it is no easy task to picture them to our minds. On the other hand, we see in the heavens arrangements of matter on a scale so vast that it is equally difficult to grasp. Both the inconceivably small and the inconceivably large should fall under a general law, if it is a true one; and the history of satellites, planets and stars presents at least as great an interest as that of atoms and molecules. Accordingly the transition from the small to the large seemed to afford a convenient halting place in my address, and I propose to-night to resume the discussion by considering various theories of celestial evolution. But I will first try to render the point of view intelligible which I desire to take. A short preliminary explanation for those who were not at Cape Town thus becomes necessary.

I desire to present the essential features which are common to evolution in all its branches, and this may be done most easily

[1]Johannesburg, South Africa, August 30, 1905.

by reference to political institutions, because we all fancy we understand something of politics.

The complex interactions of man with man in a community are usually described by such comprehensive terms as 'the state,' 'the commonwealth' or 'the government.' Various states differ widely in their constitution and in the degree of the complexity of their organization, and we classify them by various general terms, such as 'autocracy,' 'aristocracy' or 'democracy,' which express somewhat loosely their leading characteristics. But for the purpose of showing the analogy with physics we need terms of wider import than those habitually used in politics. All forms of the state imply inter-relationship in the actions of men, and action implies movement. Thus the state may be described as a configuration or arrangement of a community of men; or we may say that it implies a definite mode of motion of men—that is to say, an organized scheme of action of man on man. Political history gives an account of the gradual changes in such configurations or modes of motion of men as have possessed the quality of persistence or of stability to resist the disintegrating influence of surrounding circumstances.

In the history of a state we find this stability or power of persistence continually changing. It slowly rises to a maximum, and then declines; when it falls to nothing a revolution ensues, and a new form of government is established. This new mode of motion of men, or government, has at first but little stability, but it gradually acquires strength and permanence, until in its turn the slow decay in the power of persistence leads on to a new revolution. Such crises in political history may give rise to a condition in which the state is incapable of perpetuation by transformation. This occurs when a savage tribe nearly exterminates another and leads the few survivors into slavery; the previous form of government then becomes extinct.

Now turn to the evolution of the various forms of life. The fundamental idea in the theory of natural selection is the persistence of those types of life which are adapted to their surrounding conditions, and the elimination by extermination of the ill-adapted types. The struggle for life amongst forms possessing various degrees of adaptation to slowly varying conditions is held to explain the transmutation of species. Although a different phraseology is used when we speak of the physical world, yet the idea is essentially the same. Theories of physical evolution involve the discovery of modes of motion or configurations of matter which are capable of persistence. The physicist describes such types as stable; the biologist calls them species.

The physicist, the biologist and the historian alike watch the effect of slowly varying external conditions; they all observe the rise and decline of stability, with the consequent change of type of motion, transmutation of species or revolution.

And now after this preface I turn to astronomical theories of evolution.

The German astronomer Bode long ago propounded a simple empirical law concerning the distances at which the several planets move about the sun, and his formula embraces so large a number of cases with accuracy that we are compelled to believe that it arises in some manner from the primitive conditions of the planetary system.

The explanation of the causes which have led to this simple law as to the planetary distances presents an interesting problem, and although it is still unsolved, we may obtain some insight into its meaning by considering what may be called a working model of ideal simplicity.

Imagine, then, a sun round which there moves in a circle a single large planet. I will call this planet Jove, because it may be taken as a representative of our largest planet, Jupiter. Suppose next that a meteoric stone or small planet is projected in any perfectly arbitrary manner in the same plane in which Jove is moving; then we ask how this third body will move. It appears that under the combined attractions of the sun and Jove the meteoric stone will in general describe an orbit of extraordinary complexity, at one time moving slowly at a great distance from both the sun and Jove, at other times rushing close past one or other of them. As it grazes past Jove or the sun it may often but just escape a catastrophe, but a time will come at length when it runs its chances too fine and comes into actual collision. The individual career of the stone is then ended by absorption, and of course by far the greater chance is that it will find its Nirvana by absorption in the sun.

Next let us suppose that instead of one wandering meteoric stone or minor planet there are hundreds of them, moving initially in all conceivable directions. Since they are all supposed to be very small, their mutual attractions will be insignificant, and they will each move almost as though they were influenced only by the sun and Jove. Most of these stones will be absorbed by the sun, and the minority will collide with Jove.

When we inquire how long the career of a stone may be, we find that it depends on the direction and speed with which it is started, and that by proper adjustment the delay of the final catastrophe may be made as long as we please. Thus by making the delay indefinitely long we reach the conception of a meteoric stone which moves so as never to come into collision with either body.

There are, therefore, certain perpetual orbits in which a meteoric stone or minor planet may move forever without collision. But when such an immortal career has been discovered for our minor planet, it still remains to discover whether the slightest possible departure from the prescribed orbit will become greater and greater and ultimately lead to a collision with the sun or Jove, or whether the body will travel so as to cross and recross the exact perpetual orbit, always remaining close to it. If the slightest departure inevitably increases as time goes on, the orbit is unstable; if, on the other hand, it only leads to a slight waviness in the path described, it is stable.

We thus arrive at another distinction: there are perpetual orbits, but some, and indeed most, are unstable, and these do not offer an immortal career for a meteoric stone; and there are other perpetual orbits which are stable or persistent. The unstable ones are those which succumb in the struggle for life, and the stable ones are the species adapted to their environment.

If, then, we are given a system of a sun and large planet, together with a swarm of small bodies moving in all sorts of ways, the sun and planet will grow by accretion, gradually sweeping up the dust and rubbish of the system, and there will survive a number of small planets and satellites moving in certain definite paths. The final outcome will be an orderly planetary system in which the various orbits are arranged according to some definite law.

There is hardly room for doubt that if a complete solution for our solar system were attainable, we should find that the orbits of the existing planets and satellites are numbered amongst the stable perpetual orbits, and should thus obtain a rigorous mechanical explanation of Bode's law concerning the planetary distances.

In the first portion of my address I described the orbits in which the corpuscles move in the atoms of matter, and drew

attention to the resemblance to a planetary system. It may not, perhaps, be fanciful to imagine that some general mathematical method devised for solving a problem of cosmical evolution may find another application to miniature atomic systems, and may thus lead onward to vast developments of industrial mechanics. Science, however diverse its aims, is a whole, and men of science do well to impress on the captains of industry that they should not look askance on those branches of investigation which may seem for the moment far beyond any possibility of practical utility.

The theory which I have now explained points to the origin of the sun and planets from gradual accretions of meteoric stones, and it makes no claim to carry the story back behind the time when there was already a central condensation or sun about which there circled another condensation or planet. But more than a century ago an attempt had already been made to reconstruct the history back to a yet remoter past, and, as we shall see, this attempt was based upon quite a different supposition as to the constitution of the primitive solar system. I myself believe that the theory I have just explained, as well as that to which I am coming, contains essential elements of truth, and that the apparent discordances will some day be reconciled. The theory of which I speak is the celebrated nebular hypothesis, first suggested by the German philosopher Kant, and later restated independently and in better form by the French mathematician Laplace.

Laplace traced the origin of the solar system to a nebula or cloud of rarefied gas congregated round a central condensation which was ultimately to form the sun. The whole was slowly rotating about an axis through its center, and, under the combined influences of rotation and of the mutual attraction of the gas, it assumed a globular form, slightly flattened at the poles. The primeval globular nebula is undoubtedly a stable or persistent figure, and thus Laplace's hypothesis conforms to the general laws which I have attempted to lay down.

The nebula must have gradually cooled by radiation into space, and as it did so the gas must necessarily have lost some of its spring or elasticity, thus permitting a greater degree of condensation of the whole. The contraction led inevitably to two results: first, the central condensation became hotter; and, secondly, the speed of its rotation became faster. The accelerated rotation led to an increase in the amount of polar flattening, and the nebula at length assumed the form of a lens, or of a disk thicker in the middle than at the edges. Assuming the existence of the primitive nebula, the hypothesis may be accepted thus far as practically certain.

From this point, however, doubt and difficulty enter into the argument. It is supposed that the nebula became so much flattened that it could not subsist as a continuous aggregation of gas, and a ring of matter detached itself from the equatorial regions. The central portions of the nebula, when relieved of the excrescence, resumed the more rounded shape formerly possessed by the whole. As the cooling continued, the central portion in its turn became excessively flattened through the influence of its increased rotation; another equatorial ring then detached itself, and the whole process was repeated as before. In this way the whole nebula was fissured into a number of rings surrounding the central condensation, whose temperature must by then have reached incandescence.

Each ring then aggregated itself round some nucleus which happened to exist in its circumference, and so formed a subordinate nebula. Passing through a series of transformations, like its parent, this nebula was

finally replaced by a planet with attendant satellites.

The whole process forms a majestic picture of the history of our system. But the mechanical conditions of a rotating nebula are too complex to admit, as yet, of complete mathematical treatment; and thus, in discussing this theory, the physicist is compelled in great measure to adopt the qualitative methods of the biologist, rather than the quantitative ones which he would prefer.

Although the telescope seems to confirm the general correctness of Laplace's hypothesis, yet it is hardly too much to say that every stage in the supposed process presents to us some impossibility.

Thus, for example, the ring of Saturn seems to have suggested the theory to Laplace; but to take it as a model leads us straight to a quite fundamental difficulty. If a ring of matter ever concentrates under the influence of its mutual attraction, it can only do so round the center of gravity of the whole ring. Therefore the matter forming an approximately uniform ring, if it concentrates at all, can only fall in on the parent planet and be reabsorbed. Some external force other than the mutual attraction of the matter forming the ring, and, therefore, not provided by the theory, seems necessary to effect the supposed concentration. The only way of avoiding this difficulty is to suppose the ring to be ill-balanced or lop-sided; in this case, provided the want of balance is pronounced enough, concentration will take place round a point inside the ring but outside the planet.

However, this is not the time to pursue these considerations further, yet enough has been said to show that the nebular hypothesis can not be considered as a connected intelligible whole, however much of truth it may contain.

In the first theory which I sketched as to the origin of the sun and planets, we supposed them to grow by the accretions of meteoric wanderers in space, and this hypothesis is apparently in fundamental disagreement with the conception of Laplace, who watches the transformations of a continuous gaseous nebula. I must not pause to consider how these seemingly discordant views may be reconciled, but will merely say that I conceive both theories contain important elements of truth.

We have seen that, in order to explain the genesis of planets according to Laplace's theory, the rings must be ill-balanced or even broken. If the ring were so far from being complete as only to cover a small segment of the whole circumference, the true features of the occurrences in the births of planets and satellites might be better represented by conceiving the detached portion of matter to have been more or less globular from the first, rather than ring-shaped. Now this idea introduces us to another group of researches whereby mathematicians have sought to explain the birth of planets and satellites.

The solution of the problem of evolution involves the search for those persistent or stable forms which biologists would call species. The species of which I am now going to speak may be grouped in a family, which comprises all those various forms which a mass of rotating liquid is capable of assuming under the conjoint influences of gravitation and rotation. If the earth were formed throughout of a liquid of the same density, it would be one of the species of this family; and indeed these researches date back to the time of Newton, who was the first to explain the figures of planets.

The ideal liquid planets we are to consider must be regarded as working models of actuality, and inasmuch as the liquid is supposed to be incompressible, the conditions depart somewhat widely from those of reality. Hence, when the problem has

been solved, much uncertainty remains as to the extent to which our conclusions will be applicable to actual celestial bodies.

We begin, then, with a rotating liquid planet like the earth, which is the first stable species of our family. We next impart in imagination more rotation to this planet, and find by mathematical calculation that its power of resistance to any sort of disturbance is less than it was. In other words, its stability declines with increased rotation, and at length we reach a stage at which the stability just vanishes. At this point the shape is a transitional one, for it is the beginning of a new species with different characteristics from the first, and with a very feeble degree of stability or power of persistence. As a still further amount of rotation is imparted, the stability of the new species increases to a maximum and then declines until a new transitional shape is reached and a new species comes into existence. In this way we pass from species to species with an ever-increasing amount of rotation.

The first or planetary species has a circular equator like the earth; the second species has an oval equator, so that it is something like an egg spinning on its side on a table; in the third species we find that one of the two ends of the egg begins to swell, and that the swelling gradually becomes a well-marked protrusion or filament. Finally, the filamentous protrusion becomes bulbous at its end, and is only joined to the main mass of liquid by a gradually thinning neck. The neck at length breaks, and we are left with two separated masses which may be called planet and satellite.

In this ideal problem the successive transmutations of species are brought about by gradual additions to the amount of rotation with which the mass of liquid is endowed. It might seem as if this continuous addition to the amount of rotation were purely arbitrary and could have no counterpart in nature. But real bodies cool and contract in cooling, and I must ask you to believe that the effects of an apparently arbitrary increase of rotation may be produced by cooling.

The figures which I succeeded in drawing, by means of rigorous calculation, of the later stages of this course of evolution, are so curious as to remind one of some such phenomenon as the protrusion of a filament of protoplasm from a mass of living matter, and I suggest that we may see in this almost life-like process the counterpart of at least one form of the birth of double stars, planets and satellites.

My Cambridge colleague, Jeans, has also made an interesting contribution to the subject by attacking the far more difficult case where the rotating fluid is a compressible gas. In this case also he finds a family of types, but the conception of compressibility introduced a new set of considerations in the transitions from species to species. The problem is, however, of such difficulty that he had to rest content with results which were rather qualitative than strictly quantitative.

It can not be doubted that the supposed Laplacian sequence of events possesses a considerable element of truth, yet these latter schemes of transformation can be followed in closer detail. It seems, then, probable that both processes furnish us with crude models of reality, and that in some cases the first and in others the second is the better representative.

The moon's mass is one eightieth of that of the earth, whereas the mass of Titan, the largest satellite in the solar system, is one forty-sixth hundredths of that of Saturn. On the ground of this great difference between the relative magnitudes of all other satellites and of the moon, it is not unreasonable to suppose that the mode of separation of the moon from the earth

may also have been widely different. The theory of which I shall have next to speak claims to trace the gradual departure of the moon from an original position not far removed from the present surface of the earth. If this view is correct we may suppose that the detachment of the moon from the earth occurred as a single portion of matter, and not as a concentration of a Laplacian ring.

If a planet is covered with oceans of water and air, or if it is formed of plastic molten rock, tidal oscillations must be generated in its mobile parts by the attractions of its satellites and of the sun. Such movements must be subject to frictional resistance, and the planet's rotation will be slowly retarded by tidal friction in much the same way that a fly-wheel is gradually stopped by any external cause of friction. Since action and reaction are equal and opposite, the action of the satellites on the planet, which causes the tidal friction of which I speak, must correspond to a reaction of the planet on the motion of the satellites.

At any moment of time we may regard the system composed of the rotating planet with its attendant satellite as a stable species of motion, but the friction of the tides introduces forces which produce a continuous, although slow, transformation in the configuration. It is, then, clearly of interest to trace backwards in time the changes produced by such a continuously acting cause, and to determine the initial condition from which the system of planet and satellite must have been slowly degrading. We might also look forward, and discover whither the transformation tends.

Let us consider, then, the motion of the earth and moon revolving in company round the sun, on the supposition that the friction of the tides in the earth is the only effective cause of change. We are, in fact, to discuss a working model of the system, analogous to those of which I have so often spoken before; and it must suffice to set forth the result in its main outline as referring only to the past.

If we take the 'day,' regarding it as a period of variable length, to mean the time occupied by a single rotation of the earth on its axis; and the 'month,' likewise variable in absolute length, to mean the time occupied by the moon in a single revolution round the earth, the number of days in the month expresses the speed of the earth's rotation relatively to the speed of the moon's revolution.

Now in our retrospect both day and month are found continuously shortening; but as on the whole the month shortens much more quickly than the day, the number of days in the month also falls. We may, then, ask at once, What is the initial stage to which the gradual transformation points? I say, that on following the argument to its end the system may be traced back to a time when the day and month were identical in length, and were both only about four or five of our present hours. The identity of day and month means that the moon was always opposite to the same side of the earth; thus at the beginning the earth always presented the same face to the moon, just as the moon now always shows the same face to us. Moreover, when the month was only some four or five of our present hours in length the moon must have been only a few thousand miles from the earth's surface—a great contrast with the present distance of 240,000 miles.

It might well be argued from this conclusion alone that the moon separated from the earth more or less as a single portion of matter at a time immediately antecedent to the initial stage to which she has been traced. But there exists a yet more weighty argument favorable to this view, for it appears that the initial stage is one

in which the stability of the species of motion is tottering, so that the system presents the characteristic of a transitional form, which we have seen to denote a change of type or species in a previous case.

In discussing the transformations of a liquid planet we saw the tendency of the single mass to divide into two portions, and now we seem to reach a similar crisis from the opposite end, when in retrospect we trace back the system to two masses of unequal sizes in close proximity with one another. The argument almost carries conviction with it, but I have necessarily been compelled to pass over various doubtful points.

Time is wanting to consider other subjects worthy of notice which arise out of this problem, yet I wish to point out the fact that tidal friction is competent to explain the eccentricity of an orbit, because this conclusion has been applied in a manner to which I shall have occasion to return hereafter.

If, as has been argued, tidal friction has played so important a part in the history of the earth and moon, it might be expected that the like should be true of the other planets and satellites, and of the planets themselves in their relationship to the sun. But numerical examination of the several cases proves conclusively that this can not have been the case. The relationship of the moon to the earth is in fact quite exceptional in the solar system, and we have still to rely on such theories as that of Laplace for the explanation of the main outlines of the solar system.

I have not yet mentioned the time occupied by the sequence of events sketched out in the various schemes of cosmogony, and the question of cosmical time is a thorny and controversial one.

Our ideas are absolutely blank as to the time requisite for the evolution either according to Laplace's nebular hypothesis, or the meteoritic theory. All we can assert is that they demand enormous intervals of time as estimated in years.

The theory of tidal friction stands alone amongst these evolutionary speculations in that we can establish an exact but merely relative time-scale for every stage of the process. Although it is true that the value in years of the unit of time remains unknown, yet it is possible to determine a period in years which must be shorter than that in which the whole history is comprised. If at every moment since the birth of the moon tidal friction had always been at work in such a way as to produce the greatest possible effect, then we should find that sixty million years would be consumed in this portion of evolutionary history. The true period must be much greater, and it does not seem unreasonable to suppose that 500 to 1,000 million years may have elapsed since the birth of the moon. Such an estimate would not seem extravagant to geologists who have, in various ways, made exceedingly rough determinations of geological periods.

As far as my knowledge goes I should say that pure geology points to some period intermediate between 50 and 1,000 millions of years, the upper limit being more doubtful than the lower. Thus far we do not find anything which renders the tidal theory of evolution untenable.

But the physicists have formed estimates in other ways which, until recently, seemed to demand in the most imperative manner a far lower scale of time. According to all theories of cosmogony, the sun is a star which became heated in the process of its condensation from a condition of wide dispersion. When a meteoric stone falls into the sun the arrest of its previous motion gives rise to heat, just as the blow of a horse's shoe on a stone makes a spark. The fall of countless meteoric stones, or the

condensation of a rarefied gas, was supposed to be the sole cause of the sun's high temperature.

Since the mass of the sun is known, the total amount of the heat generated in it, in whatever mode it was formed, can be estimated with a considerable amount of precision. The heat received at the earth from the sun can also be measured with some accuracy, and hence it is a mere matter of calculation to determine how much heat the sun sends out in a year. The total heat which can have been generated in the sun divided by the annual output gives a quotient of about 20 millions. Hence it seemed to be imperatively necessary that the whole history of the solar system should be comprised within some 20 millions of years.

This argument, which is due to Helmholtz, appeared to be absolutely crushing, and for the last forty years the physicists have been accustomed to tell the geologists that they must moderate their claims. But for myself I have always believed that the geologists were more nearly correct than the physicists, notwithstanding the fact that appearances were so strongly against them.

And now, at length, relief has come to the strained relations between the two parties, for the recent marvelous discoveries in physics show that concentration of matter is not the only source from which the sun may draw its heat.

Radium is a substance which is perhaps millions of times more powerful than dynamite. Thus it is estimated that an ounce of radium would contain enough power to raise 10,000 tons a mile above the earth's surface. Another way of stating the same estimate is this: the energy needed to tow a ship of 12,000 tons a distance of six thousand sea miles at 15 knots is contained in 22 ounces of radium. The *Saxon* probably burns five or six thousand tons of coal on a voyage of approximately the same length. Other lines of argument tend in the same direction.

Now we know that the earth contains radioactive materials, and it is safe to assume that it forms in some degree a sample of the materials of the solar system; hence it is almost certain that the sun is radioactive also.

This branch of science is as yet but in its infancy, but we already see how unsafe it is to dogmatize on the potentialities of matter. It appears, then, that the physical argument is not susceptible of a greater degree of certainty than that of the geologists, and the scale of geological time remains in great measure unknown.

I have now ended my discussion of the solar system, and must pass on to the wider fields of the stellar universe.

Only a few thousand stars are visible with the unaided eye, but photography has revealed an inconceivably vast multitude of stars and nebulæ, and every improvement in that art seems to disclose yet more and more. It seems useless to consider whether the number of stars has any limit, for infinite number, space and time transcend our powers of comprehension. We must then make a virtue of necessity, and confine our attention to such more limited views as seem within our powers.

A celestial photograph looks at first like a dark sheet of paper splashed with whitewash, but further examination shows that there is method in the arrangement of the white spots. Thus there is order of some sort in the heavens, and, although no reason can be assigned for the observed arrangement in any particular case, yet it is possible to obtain general ideas as to the succession of events in stellar evolution.

Besides the stars there are numerous streaks, wisps and agglomerations of nebulosity, whose light we know to emanate

from gas. Spots of intenser light are observed in less brilliant regions; clusters of stars are sometimes imbedded in nebulosity, while in other cases each individual star of a cluster stands out clear by itself. These and other observations force on us the conviction that the wispy clouds represent the earliest stage of development, the more condensed nebulæ a later stage, and the stars themselves the last stage. This view is in agreement with the nebular hypothesis of Laplace, and we may fairly conjecture that chains and lines of stars represent preexisting streaks of nebulosity.

Change is obviously in progress everywhere, as well in each individual nebula and star as in the positions of these bodies relatively to one another. But we are unable even to form conjectures as to the tendency of the evolution which is going on. This being so, we can not expect, by considering the distribution of stars and nebulæ, to find many illustrations of the general laws of evolution which I have attempted to explain; accordingly I must confine myself to the few cases where we at least fancy ourselves able to form ideas as to the stages by which the present conditions have been reached.

Up to a few years ago there was no evidence that the law of gravitation extended to the stars, and even now there is nothing to prove the transmission of gravity from star to star. But in the neighborhood of many stars the existence of gravity is now as clearly demonstrated as within the solar system itself. The telescope has disclosed the double character of a large number of stars, and the relative motion of the pairs of companions has been observed with the same assiduity as that of the planets. When the relative orbit of a pair of binary or double stars is examined, it is found that the motion conforms exactly to those laws of Kepler which prove that the planets circle round the sun under the action of solar gravitation. A leading characteristic of all these double stars is that the two companions do not differ enormously in mass from one another. In this respect these systems present a strongly marked contrast with that of the sun, attended as it is by relatively insignificant planets.

In the earlier part of my address I showed how theory indicates that a rotating fluid body will as it cools separate into two detached masses. Mathematicians have not yet been able to carry their analysis far enough to determine the relative magnitudes of the two parts, but as far as we can see the results point to the birth of a satellite whose mass is a considerable fraction of that of its parent. Accordingly See (who devotes his attention largely to the astronomy of double stars), Alexander Roberts and others consider that what they have observed in the heavens is in agreement with the indications of theory. It thus appears that there is reason to hold that double stars have been generated by the division of primitive and more diffused single stars.

But if this theory is correct we should expect the orbit of a double star to be approximately circular; yet this is so far from being the case that the eccentricity of the orbits of many double stars exceeds by far any of the eccentricities in the solar system. Now See has pointed out that when two bodies of not very unequal masses revolve round one another in close proximity the conditions are such as to make tidal friction as efficient as possible in transforming the orbit. Hence we seem to see in tidal friction a cause which may have sufficed not only to separate the two component stars from one another, but also to render the orbit eccentric.

I have thought it best to deal very briefly with stellar astronomy in spite of the importance of the subject, because the direc-

tion of the changes in progress is in general too vague to admit of the formation of profitable theories.

We have seen that it is possible to trace the solar system back to a primitive nebula with some degree of confidence, and that there is reason to believe that the stars in general have originated in the same manner. But such primitive nebulæ stand in as much need of explanation as their stellar offspring. Thus, even if we grant the exact truth of these theories, the advance towards an explanation of the universe remains miserably slight. Man is but a microscopic being relatively to astronomical space, and he lives on a puny planet circling round a star of inferior rank. Does it not, then, seem as futile to imagine that he can discover the origin and tendency of the universe as to expect a housefly to instruct us as to the theory of the motions of the planets? And yet, so long as he shall last, he will pursue his search, and will no doubt discover many wonderful things which are still hidden. We may indeed be amazed at all that man has been able to find out, but the immeasurable magnitude of the undiscovered will throughout all time remain to humble his pride. Our children's children will still be gazing and marveling at the starry heavens, but the riddle will never be read.

G. H. DARWIN.

SCIENTIFIC BOOKS.

Index Filicum, sive Enumeratio omnium generum specierumque Filicum et Hydropteridum ab anno 1753 ad annum 1905 descriptorum adjectis synonymis principalibus, area geographica, etc. By CARL CHRISTENSEN. Copenhagen, H. Hagerup. Fasc. I, pp. 1–64, May 5, 1905; fasc. II, pp. 65–128, July 1, 1905. Price 3s. 6d. per fascicle.

The present notice of the first two fascicles of Herr Christensen's 'Index Filicum' is offered not so much in the nature of a review as with the especial purpose of calling the work to the attention of botanists and librarians, and of urging the desirability of immediate and deserved support. For, as we have been informed by the author, unless very definite encouragment is given at once in the shape of additional subscriptions it will be impossible to bring the printing to a successful conclusion. The manuscript is said to be quite complete, comprising ten or twelve parts in all, the result of years of patient, tedious effort. How unfortunate the discontinuance of publication would be is realized most by those who have borne in some measure the burden imposed by the lack of such a compendium.

The work when complete is to be under three heads: (1) A systematic enumeration of the genera of ferns, based mainly upon the treatment of Engler and Prantl; (2) an alphabetical arrangement of all valid specific names and synonyms published from 1753 to 1905, with mention of names in use among gardeners; (3) an alphabetical catalogue of references to the principal systematic literature of ferns. Of these it is undoubtedly the second which, under present conditions, will prove of greatest service to botanists; yet the first is assuredly a great desideratum, and the last will be of unusual benefit to younger students.

The want of an index has been pressing. An authoritative estimate upon the validity of the exceedingly numerous species proposed in the past is, of course, a prime consideration; but it can not be denied that this is best determined, or at least maintained, in an extended descriptive work that shall afford a general view of related species. It is too much to expect that in the present instance the treatment of species will carry the weight of monographic authority. Nevertheless, there is every indication that the author's estimate is a fair one; and, at any rate, deviation from this treatment will not detract materially from the usefulness of the work.

The main value of the volume will reside in the strictly bibliographic phase; the chief requirement being, in brief, that we may be able

to determine readily under which genera a given specific name has been applied, precisely at what place and, incidentally, by whom. The nomenclatorial confusion resulting from the widely differing schemes of classification adopted by various writers has long since become so pronounced as to offer a very serious obstacle to constructive work. What the 'Index Kewensis' has meant to botanists in general and Paris's 'Index Bryologicus' latterly to students of mosses, those who have dealt with ferns have realized only partially, hitherto, in consulting Moore's 'Index Filicum,' a work that was printed from A only midway through G in the years 1857–1862. It is true that Salamon's 'Nomenclator der Gefässkryptogamen' (1883) has been of assistance, although citations are entirely omitted; but, if we consider the activity of fern students in the last two decades alone, it becomes evident from the wide range of descriptions in periodicals—botanical and otherwise—how little security in the use of new specific names has been justified, and some idea may be gained of the difficulties that have lain in the way of ready reference to original descriptions. Christensen's 'Index' is designed to meet this condition. Judging from the character of the two parts at hand we have little doubt that opinion can not fail eventually to be substantially and deservedly favorable.

With regard to the mechanical execution of the work little but praise may be said. The typography is exceedingly well adapted to its purpose; and the method of citation is practically in accord with the common American usage, the sequence being: (1) name, (2) author, (3) title of serial, (4) series, if any, in Roman capitals, (5) volume number in bold-faced Arabic, (6) page and (7) date. In a very few cases well-known works and periodicals are abbreviated in an extreme fashion which, for the sake of avoiding cumbrous repetition seems quite justified. Accepted species stand under their proper genera in heavy-faced print; very doubtful species and those known only among gardeners in italics; synonyms in ordinary brevier. The listing of subgenera in distinctive typography is also to be strongly commended; for, although our latest American rules contain no provision that these must be taken up in the event of segregation, yet the desirability of their later use is scarcely open to question, and it is of high importance that such as are needed be used in their proper sense and that all be held available.

There is evidence of great care in citation, and of unusual effort to prevent a possible misconception as to the authorship and publication of new names and 'new combinations,' of which there are of necessity a good many. In transferring a species from one genus to another, the resulting binomial, if new, is distinctly indicated as such; not, however, in the usual way, by the phrase 'comb. nov.' but by 'C. Chr. Ind. [page] 1905'; by which means the binary name of every recognized species—whether proposed formerly or in this volume—is accompanied by citation of publication. More than a few of Dr. Christ's species are here first referred to other than their original genera; but in most, if not all, of these cases that author is credited with the new binomial (the citation being printed 'Christ in C. Chr. Ind. [page] 1905,') in recognition of assistance received in preparation of the manuscript.

Criticism of the major systematic treatment must be deferred until the appearance of the final brochures, for not until then shall we have a formal presentation of the classification adopted, nor shall we know how widely this treatment departs from that of its professed model, Engler and Prantl. There is, however, some indication of a more liberal acceptance of genera. Still, we can not but regard *Anaxetum* Schott as worthy to stand quite apart, generically distinct, from *Polypodium;* and recent studies[1] have convinced us that a more valid genus than *Adenoderris* J. Sm. is hardly to be found in the whole range of the Dryopterideæ. In the recognition of species the policy of the author has been to follow the disposition of monographers; in this way, de Vries's numerous species of *Angiopteris* are admitted, though under protest, on the ground that there has appeared no later revision.

Aside from the preparation of a modern 'Synopsis Filicum'—an undertaking so difficult and comprehensive that, under present

[1] *Botanical Gazette,* **39**: 366–369. May, 1905.

circumstances, it may scarcely be regarded with well-founded hopes of realization—there is undoubtedly no more worthy single service to be rendered students in systematic pteridology than the publication of precisely such a work as Christensen has undertaken in his 'Index Filicum.' The need of the work is undeniable; the parts already published are of high worth; the manuscript of the remainder is ready for the printer; and we can only express our hope that the necessary support shall be given—and at once—to insure the issuance of the remaining parts.

WILLIAM R. MAXON.

U. S. NATIONAL MUSEUM,
August 15, 1905.

SCIENTIFIC JOURNALS AND ARTICLES.

THE August number of *The Physical Review* contains the following articles:

A. DE FOREST PALMER: 'Thermo-electric Determination of Temperatures 0° and 200° C.'

LOUIS BEVIER, JR.: 'The Vowel A° (as in Raw), O (as in Rope), U (as in Rude).'

WM. J. RAYMOND: 'The Measurment of Inductance and Capacity by Means of the Differential Ballistic Galvanometer.'

J. B. WHITEHEAD: 'The Magnetic Effect of Electric Displacement.'

E. R. DREW: 'The Infra-red Spectrum of CO_2 and Nitrogen.'

THE contents of *The American Naturalist* for August are as follows:

PROFESSOR D. P. PENHALLOW: 'A Systematic Study of the Salicaceæ.'

J. A. CUSHMAN: 'Developmental Stages in the Lagenidæ.'

DR. B. M. DAVIS: 'Studies on the Plant Cell.'—VII.

Notes and Literature: Nature Study; Zoology, Wasps Social and Solitary, Trouessart's Catalogue Mammalium, Supplement.

SOCIETIES AND ACADEMIES.

ORGANIZATION OF A NATIONAL SOCIETY OF TEACHERS OF MATHEMATICS AND SCIENCE.

A CONFERENCE was held at Asbury Park on July 5, 1905, for the purpose of discussing the advisability of organizing a national society of teachers of mathematics and natural science. The conference was attended by thirty-seven teachers representing nearly all the larger associations of teachers of mathematics and natural science in the United States. Many letters received from teachers who were unable to be present expressed sympathy with the proposed movement.

Professor Thomas S. Fiske, of Columbia University, was elected chairman of the conference and Dr. Arthur Schultze, of the High School of Commerce of New York, was elected secretary.

There was absolute agreement in regard to the advisability of forming closer permanent relations among the associations represented, and a large majority were in favor of effecting this by means of a national association. Considerable discussion, however, arose as to whether the new society should be one of mathematical teachers only or one including also teachers of science. The western associations, for the most part including teachers of science as well as teachers of mathematics, strongly advocated a mixed organization, while the teachers from the eastern states seemed, to a considerable extent, to favor a purely mathematical society. The views urged by the western delegates prevailed, and on motion of Professor E. R. Hedrick, of the University of Missouri, a resolution was adopted to the effect that a national society of teachers of mathematics and science be organized.

The details of the organization were referred to the following executive committee: Professor Thomas S. Fiske (chairman), New York, N. Y.; Professor C. E. Comstock, Peoria, Ill.; Professor E. R. Hedrick, Columbia, Mo.; Mr. Franklin T. Jones, Cleveland, O.; Professor William H. Metzler, Syracuse, N. Y.; Mr. Edgar H. Nichols, Cambridge, Mass.

Up to the next meeting this committee is to act as council of the society and a report of its proceedings is to be published in *School Science and Mathematics.*

In the following list of associations represented at the conference the names of regularly appointed delegates are distinguished by the letter (D).

New England Mathematics Teachers Asso-

ciation.—Chas. E. Bouton, Harvard University (D); Paul Capron (D); Mr. Nichols, Brown and Nichols School, Cambridge (D).

Association of Teachers of Mathematics in the Middle States and Maryland.—John C. Bechtel; Fletcher Durell, Lawrenceville, N. J.; A. Newton Ebaugh; Miss Susan C. Lodge; Donald C. MacLaren; Wm. H. Metzler, Syracuse University (D); J. T. Rorer, Central High School, Philadelphia (D); Arthur Schultze, High School of Commerce, N. Y. (D); H. C. Whitaker.

Central Association of Science and Mathematics Teachers.—Otis W. Caldwell; Jos. V. Collins (D); C. E. Comstock (D); G. W. Greenwood (D); Charles H. Smith; Charles M. Turton; J. W. Young, Charles W. Wright.

Missouri Society of Teachers of Mathematics.—F. T. Appleby; J. S. Bryan, Central High School, St. Louis (D); H. Clay Harvey (D); E. R. Hedrick (D); B. F. Johnston; John R. Kirk; J. W. Whiteye.

Chicago and Cook County High School Teachers' Association.—Edward E. Hill (D); Fred R. Nichols (D); Chas. M. Turton (D).

Mathematical Section of Michigan School-Master's Club.—Miss Emma C. Ackermann (D).

New York State Science Association, Mathematical Department.—Glenn M. Lee.

North Eastern Ohio Center, G.A.S. and M.T.—Lemar T. Beman, Cleveland High School (D); Charles A. Marple (D).

Ohio Association of Teachers of Mathematics and Science.—Franklin T. Jones (D); Wm. McLair (D).

St. Louis Association of Science and Mathematics Teachers.—Wm. Schuyler, McKinley High School, St. Louis (D).

DISCUSSION AND CORRESPONDENCE.

THE BOLYAI PRIZE.

AMERICA will rejoice that at last Hungary is honoring herself in honoring her wonder-child, John Bolyai. His marvel diamond, the most extraordinary two dozen pages in the history of human thought, appeared in America in English before it appeared in Hungary in Magyar, proud as they are of their language; and more, the American was reproduced entire in Japan before even the original was reproduced in Hungary.

An American, not a European, was the first from outside Hungary to make the journey to Máros-Vásarhely only for John Bolyai's sake and to see there the letter in Magyar which constitutes his preemption claim and title-deed to the new universe, and to publish for the first time that letter making the date 1823 ever memorable. On its publication thus in America Charles S. Peirce wrote in *The Nation,* March 17, 1892, p. 212 in a review of Halsted's Bolyai:

> There is a winningly enthusiastic letter from Bolyai János to his father, telling him of the great step. He says: "I have discovered such magnificent things that I am myself astonished at them. It would be damage eternal if they were lost. When you see them, my father, you will yourself acknowledge it. At present I can not say more than that from nothing I have created a wholly new world."

Ten years later this letter was published in Hungary in Magyar and Latin, and now comes the establishment of the great Bolyai prize (Prix Bolyai) by the Hungarian Academy of Sciences, of which the statutes are as follows:

> 1. On the occasion of the hundredth anniversary of the birth of John Bolyai the Hungarian Academy of Sciences wishing to perpetuate the memory of this illustrious scientist, as likewise that of the profound thinker, Farkas Bolyai, his father and teacher, has decided to establish a prize to be called the Bolyai Prize. This prize, which is to consist of a commemorative medal—whose obverse will represent the academy with the view of Budapest, and whose reverse will bear an inscription—and of a sum of ten thousand crowns, shall be adjudged for the first time in 1905, then every five years, to the author of the best work in mathematics published during the five preceding years.
>
> The prize may be given to any work deemed worthy of it, whatever the language in which it be written, and in whatever form it be published.
>
> The announcement of the winner will take place during the general meeting of the academy in December.
>
> 2. In case the work of a deceased author be deemed worthy the prize, this shall be given to his heirs.
>
> 3. The third section of the academy, section of

sciences, is entrusted with constituting, at its March meeting, a committee composed of two home and two foreign members, whose duty it shall be to judge of the value of the works. The committee will meet at Budapest in the first fortnight of October, and name from their number a president and a reporter.

In case of a tie the president's vote is preponderant.

It shall be the duty of the reporter to present a detailed report on the committee's decision.

This report is to be read at the general meeting of the Academy of Sciences the day the prize is adjudged.

4. The works of authors on the committee are excluded from the competition, and they are not to be mentioned in the committee's report.

5. The foreign members designated as part of the committee and who, participating in the deliberations, will spend some days at Budapest, shall receive a compensation of 1,000 crowns. The honorarium accorded to the reporter for his work is fixed at 300 crowns.

6. The report is to be published in the journal 'Akadémiai Értesitő.' The Hungarian Academy of Sciences will publish this report abroad, and will make it known to all the associated academies.

In accordance with the above statutes, in the course of this present year the Hungarian Academy of Sciences will confer for the first time the Bolyai Prize, consisting of a medal and ten thousand crowns.

The commission constituted by the academy from its members and endowed with the powers of a jury consists of Gaston Darboux (Paris), Felix Klein (Göttingen), Julius König (Budapest), Gustav Rados (Budapest). The deliberations of this commission will be held this October in Budapest.

If I may be forgiven for a bit of prophecy, I venture to predict the prize goes to Poincaré.

GEORGE BRUCE HALSTED.

KENYON COLLEGE,
GAMBIER, OHIO.

SPECIAL ARTICLES.

ON THE PROBABLE ORIGIN OF CERTAIN BIRDS.

IT is my purpose to examine in this article the status of nine kinds of birds that have been recorded from North America, and one that has been taken in southern Europe, and to discuss in some detail their relationship and probable origin.

Appended to the 'Check-list of North American Birds' published by the American Ornithologists' Union there is a 'Hypothetical List' consisting of twenty-eight different birds which, for various reasons, have an uncertain status in the bird fauna of the region for which the list is given. Of these twenty-eight birds I shall consider nine, as from the evidence at hand it would appear that together they throw much light on some hitherto obscure problems. The list includes Cooper's sandpiper, *Tringa cooperi* Baird; Brewster's linnet, *Acanthis brewsterii* Ridgway; Townsend's bunting, *Spiza townsendii* (Audubon); Lawrence's warbler, *Helminthophila lawrencii* (Herrick); Brewster's warbler, *Helminthophila leucobronchialis* (Brewster); Carbonated warbler, *Dendroica carbonata* (Audubon); Blue Mountain warbler, *Dendroica montana* (Wilson); Small-headed warbler, *Wilsonia microcephala* (Ridgway); Cuvier's kinglet, *Regulus cuvierii* Audubon.

Of these nine kinds of birds seven either are represented by single individuals or are known only from figures and descriptions in the works of Audubon and Wilson. On the other hand, the two remaining birds of this series are known by numerous specimens, and my reasons for including them will be presented as each is considered in detail.

It seems essential at this point to call attention to the fact that a number of these birds were discovered at a time when field naturalists were not nearly so numerous as at the present day, and that there may be no doubt as to the reality of at least some of these forms, a number of the types still exist, as will presently be shown.

COOPER'S SANDPIPER, TRINGA COOPERI BAIRD.

Cooper's sandpiper is known from a single individual that was taken on Long Island in May, 1833. The type is still in the National Museum at Washington. The evident relationship of this bird to the knot, *Tringa canutus* Linnæus, is at once apparent to a student, and even an untrained eye might readily distinguish their similarity. For the

original account of the type of this species the reader is referred to 'The Birds of North America,' Baird, 1858, page 716.

BREWSTER'S LINNET, ACANTHIS BREWSTERII RIDGWAY.

The type specimen of Brewster's linnet was taken by Mr. William Brewster at Waltham, Mass., on November 1, 1870. The bird is a female. The type still exists in the collection of Mr. Brewster at Cambridge, and no other individual of this kind is known. In appearance the bird differs from other members of the genus in which it has been placed by Mr. Ridgway chiefly in lacking the red spot on top of the head and the dusky spot on the chin characteristic of the adults, especially the males of the genus *Acanthis*. Therefore, the exact relationship of this bird is somewhat obscure, though its generic status has not been questioned. For the original description of this species the reader is referred to the *American Naturalist* of July, 1872, page 433.

TOWNSEND'S BUNTING, SPIZA TOWNSENDII (AUDUBON).

On May 11, 1833, Mr. J. K. Townsend, obtained, while collecting, the type specimen on which this form is based. It is an adult male, and remains unique. The relationship of this bird is obvious; it can only be regarded as the close ally of the dickcissel, *Spiza americana* (Gmelin). (Cf. Audubon's 'Ornithological Biography,' Vol. II., p. 183, 1834.)

Commenting on the status of this bird the Committee of the Ornithologists' Union say: 'Its peculiarities can not be accounted for by hybridism nor probably by individual variation.'[1]

CARBONATED WARBLER, DENDROICA CARBONATA (AUDUBON).

This bird is known only from Audubon's colored plate and his description of two specimens killed near Henderson in Kentucky in May, 1811. The birds were probably both males. Audubon's account of the event may be found in the 'Ornithological Biography,' Vol. I., p. 308, pl. 60, 1831.

BLUE MOUNTAIN WARBLER, DENDROICA MONTANA (WILSON).

The Blue Mountain warbler is only known from the works of Wilson and Audubon. The specimens on which they based their descriptions were taken in the Blue Ridge Mountains of Virginia. The bird was figured, but no specimens are at present known. (Cf. Wilson, 'American Ornithology,' Vol. V., p. 113, pl. 44, fig. 2, 1812.)

SMALL-HEADED WARBLER, WILSONIA MICROCEPHALA (RIDGWAY).[2]

This again is one of the species described by both Wilson and Audubon. It is said to have been taken in points so widely separated as New Jersey and Kentucky, but is only known by the colored plates and the descriptions made by the above naturalists. It does not seem probable that with all the careful detailed work that has been done in both regions during the last fifty years the small-headed warbler is till extant. The bird is so widely different from any of its congeners as to make confusion with them impossible, nor has the theory of hybridity been advanced to account for this supposed species. There then remain the two hypotheses as to the status of *Wilsonia microcephala;* either the individuals which came under the observation of Wilson and Audubon were the last survivors of this species which was dying out and has become extinct, or these birds were '*mutations*' that occurred ephemerally and did not flourish, but died out almost immediately.[3]

CUVIER'S KINGLET, REGULUS CUVIERII AUDUBON.

On June 8, 1812, Audubon obtained on the banks of the Schuylkill River, at a place called Flatland Ford, in Pennsylvania, the only specimen of Cuvier's kinglet known. If

[1] 'A. O. U. Check list N. A. Birds,' 2d edition, p. 331, 1895.

[2] *Muscicapa minuta* Wilson (cf. *Am. Orn.*, Wilson., Vol. VI., p. 62, 1812, pl. 1, fig. 5, nec. Gmelin, 1788).

[3] Cf. Ridgway, *Pro. U. S. Nat. Mus.*, Vol. VIII., p. 354, 1885.

the bird was preserved the specimen has probably been either lost or destroyed, and we know it only by the admirable plate which Audubon left and by his description of the little bird.[4]

It does not seem probable that other individuals of this species could have escaped the notice of the many competent naturalists who have worked in the area in question since Audubon's time.

The affinities of this little bird appear to be with *Regulus satrapa* and it now seems probable that this was a veritable '*mutation*' that did not survive.

In dealing with the foregoing seven species I have tried to find the simplest solution to account for their presence. In view of the light thrown by the succeeding examples and the data regarding the foregoing, already given, the law of parsimony compels me to consider these forms as mutations (which were not perpetuated) from *species still existing* which I have, in most cases, been able to indicate.

We have now to consider the two remaining birds making up the nine North American species. They are Brewster's warbler and Lawrence's warbler.

BREWSTER'S WARBLER, HELMINTHOPHILA LEUCOBRONCHIALIS (BREWSTER).

The type specimen of *Helminthophila leucobronchialis*[5] was taken by Mr. William Brewster at Newtonville, Mass., on May 18, 1870. The bird was a male. It was not until April, 1876, some six years afterward, that the bird was named and described by Mr. Brewster. A second specimen[6] of this species was obtained on May 12, 1877, near Clifton, Pa. It was also a male. The third recorded individual[7] was killed long before this and was discovered in the collection of the Philadelphia Academy of Natural Sciences labeled 'J. C., October 20, 1862.' The specimen had no history, but was labeled in the handwriting of John Cassin and presumably was at one time in his collection.

By the year 1885 twenty-two[8] individuals

[4] Cf. Audubon, 'Onithological Biography,' Vol. I., p. 288, pl. 55, 1832.

[5] 'Description of a New Species of *Helminthophaga*,' by Wm. Brewster, *Bulletin of the Nuttall Ornithological Club*, Vol. I., No. 1, p. 1, 1876. Original description with colored plate.

[6] 'Capture of a Second Specimen of *Helminthophaga leucobronchialis*,' by Spencer Trotter, Philadelphia, Pa., *ibid.*, Vol. II., No. 3, pp. 79–80, 1877. Mr. Trotter records in a note the capture of *H. leucobronchialis*, by Mr. Christopher D. Wood, on May 12, 1877, near Clifton, Delaware Co., Pa. The bird was a male. It was identical in appearance with the type.

[7] 'A Third Specimen of *Helminthophaga leucobronchialis*,' by Spencer Trotter, Philadelphia, Pa., *ibid.*, Vol. III., No. 1, p. 44, 1878. Mr. Trotter discovered a specimen of *H. leucobronchialis* in the collection of the Philadelphia Academy of Natural Sciences, labeled 'J. C., 20 October, 1862,' and also what he made out to be 'Not from Bell.' No sex was indicated. The bird closely resembled the type.

'Some Light on the History of a Rare Bird,' by Spencer Trotter, Philadelphia, Pa., *ibid.*, Vol. IV., No. 2, p. 59, 1879. Mr. Trotter by correspondence discovers that Mr. Bell, a taxidermist in New York, and also a naturalist, who at times assisted Audubon, recalled the fact that in the spring about 1832, at Rockland, N. Y., he shot what he supposed was a young golden-wing warbler, *H. chysoptera*. He finally sold it to a man in Philadelphia. Mr. Trotter concludes that this is the so-called Cassin specimen. Also that the words 'not from Bell' might mean 'note from Bell.'

[8] 'The White-Throated Warbler (*Helminthophaga leucobronchialis*) in Connecticut,' by William Brewster, Cambridge, Mass., *ibid.*, Vol. III., No. 2, p. 99, 1878. Mr. Brewster identifies a fourth specimen collected at Wauregan, Conn., May 25, 1875. The sex was not determined. The bird closely resembled the type. At this time Mr. Brewster regards 'The validity of this distinctly characterized species' 'as established.'

'Capture of a Fifth Specimen of the White-throated Warbler (*Helminthophaga leucobronchialis*),' by William Brewster, Cambridge, Mass., *ibid.*, Vol. III., No. 4, p. 199, 1878. This bird was taken at Suffield, Conn., July 3, 1875. This is an adult male in worn plumage. It differs somewhat from the type, chiefly in being washed with pale yellow on the pectoral region. The yellow on the wings is also restricted and the wing bars are not almost confluent as in the type.

of *H. leucobronchialis* had been secured by different collectors at various points in southern New England, the lower Hudson River Valley, New Jersey, Pennsylvania, Virginia

'Record of Additional Specimens of the White-Throated Warbler (*Helminthophaga leucobronchialis*),' by H. A. Purdie, Newton, Mass., *ibid.*, Vol. IV., No. 3, p. 184, 1879. Mr. Purdie describes four additional birds; a typical specimen collected in Hudson, Mass., in May or June, 1858. This specimen is in the possession of Williams College, Williamstown, Mass. A second bird is from Portland, Conn., where it was collected on May 22, 1875. This is a male and has a decided blotch of yellow on the breast, and a general suffusion of the lower parts with a fainter wash of this shade. There is also a slight suffusion of this color on the upper parts. The third specimen was taken at Saybrook, Conn., and was thus written of by J. N. Clark who collected it: "Took a fine male *H. leucobronchialis*, May 30 (1879); an exceptional specimen, with a patch of bright yellow across the breast from the bend of the wings. Thought it was *pinus* when I fired; notes and habits the same." A fourth bird was shot by Mr. Gunn, in Ottawa Co., Mich., and described as '*H. Gunnii*, Gibbs,' in a local newspaper. The bird is a female and was taken on May 25, 1879. It is characterized by a bright yellow breast, the color extending as far down as the abdomen and on the flanks; its crown is particularly brilliant. Mr. Robert Ridgway subsequently identified this bird as *H. leucobronchialis*, Brewster. He also comments on its unusual coloration, but says it 'is in all essential respects like the type' and further that with this 'seventh specimen thus far collected the validity of *H. leucobronchialis* may be considered as established beyond question.' (Cf. *Bull. Nutt. Orn. Club*, Vol. IV., No. 4, p. 233, 1879.)

'*Helminthophaga leucobronchialis* in New York,' by A. K. Fisher, M.D., Sing Sing, N. Y., *ibid.*, Vol. IV., No. 4, p. 234, 1879. Records an adult male taken at Sing Sing, N. Y., on August 24, 1879. The bird had a band of yellow across the breast and a slight suffusion of pale yellow on the throat; the wing bars were '*whitish*, whiter even than *H. pinus*. The back is that of a typical *H. leucobronchialis*.'

'Two More Specimens of *Helminthophaga leucobronchialis* from Sing Sing, N. Y.,' by A. K. Fisher, M.D., Sing Sing, N. Y., *ibid.*, Vol. VI., No. 4, p. 245, 1881. Records the capture of a probable female 'having a black auricular patch.' This bird was taken on July 24, 1881, near Sing Sing, N. Y. Also a specimen from the same region August 3, 1881, sex not given, 'with a yellow pectoral band, * * * the wing-bands were normal; yellow, not white.'

'Another Example of *Helminthophaga leucobronchialis* from Connecticut,' by John H. Sage, Portland, Conn. (and a footnote by William Brewster), *Auk*, Vol. I., No. 1, p. 91, 1884. Records the capture of a female at Deep River, Conn., on May 18, 1880. Mr. Brewster says in the footnote: 'It differs from the type * * * in having the yellow of the forehead partially obscured, * * * in the unusual restriction of the wing-bands, and in the generally immature appearance of the plumage.' These characteristics, he says, 'are just what would be expected in the female of this species.'

'Occurrence of *Helminthophila leucobronchialis* in Virginia,' by William Palmer, Smithsonian Institution, Washington, D. C., *Auk*, Vol. II., No. 3, p. 304, 1885. Records the capture of a male near Fort Meyer, Arlington, Va. The specimen is typical.

'A Specimen of *Helminthophila leucobronchialis* in New Jersey,' by C. B. Riker, New York City, *Auk*, Vol. II., No. 4, p. 378, 1885. Records a male collected at Maplewood, Essex Co., N. J., May 11, 1883. First record for the state. Very gray on the back, this bird has an indistinct yellow breast band and whitish wing bars much as in *pinus*, very conspicuously separated.

For change of generic name cf. Ridgway, *Bull. Nutt. Orn. Club*, Vol. VII., No. 1, p. 53, 1882.

'Capture of Two More Specimens of *Helminthophila leucobronchialis* at Sing Sing, New York,' by A. K. Fisher, M.D., Sing Sing, N. Y., *Auk*, Vol. II., No. 4, p. 378, 1885. Records the capture of two specimens at Sing Sing, N. Y., on August 11, 1883. "The under parts of both specimens are much more deeply suffused with yellow than is the case in any of my other three specimens; in fact, the yellow on one is evenly distributed over the entire under surface, but is not so deep as in *Helminthophila pinus*."

Cf. Ridgway, *Auk*, Vol. II., No. 4, pp. 359–363, October, 1885.

Cf. Thurber, *Auk*, Vol. III., No. 3, p. 411, 1886.

Remark. These are all the *recorded* individuals up to the end of 1885, but I have reason to think that there are a number of known specimens that were not recorded, and which were taken between 1878 and 1885.

and Michigan. However, the birds are most common about the lower reaches of the Connecticut and Hudson rivers. At the present writing I have no doubt that in all the collections in the country there are at least 150 individuals of *H. leucobronchialis* and, moreover, it is entirely possible, at the proper season and locality, to observe these birds annually.

Again I must insist upon the importance of considering carefully the history of the appearance of this and other probable 'mutations.' It is not likely that a form or kind of bird so common as *H. leucobronchialis* is at the present time, and ranging over as large an area as from Pennsylvania to Massachusetts and from Virginia to Michigan, should remain unknown to the earlier ornithologists, such keen field naturalists as Audubon and Wilson, Baird, Lawrence, Coues and Prentiss. Nuttall made careful and prolonged study of birds in the region where Mr. Brewster collected the type. Yet none of these close observers and good collectors either recorded or secured an individual of this kind. Clearly then, the presumption is that this bird could not have been so common early in the last century as it is now, if indeed it existed at all at that time. Nor does it seem that the theory of hybridity[8] is supported when we consider the vast number of known specimens already in collections and the fact that it is possible to observe living specimens, as I have indicated, each year. I am aware that many

[8] 'On the Relationship of *Helminthophaga leucobronchialis*, Brewster, and *Helminthophaga lawrencei*, Herrick; with some Conjectures Respecting Certain other North American Birds,' by William Brewster, *Bull. Nutt. Orn. Club*, Vol. VI., No. 4, pp. 218–225, 1881. Basing his hypothesis upon similarity of color and marking, Brewster considers these birds hybrids and says: 'Taken as a whole, this series (of seven specimens) perfectly connects *leucobronchialis* with *pinus*, as well as showing an extension of the former towards *chrysoptera*.'

'*Helminthophila leucobronchialis*,' by Robert Ridgway, *Auk*, Vol. II., No. 4, pp. 359–363, 1885. Assumes *Helminthophila leucobronchialis* to be a distinct species which hybridizes with its allies, thus accounting for the number of aberrant specimens.

'*Helminthophila leucobronchialis* in New Jersey,' by E. Carlton Thurber, Morristown, N. J., *Auk*, Vol. III., No. 3, p. 411, 1886. Records the capture by Mr. Auguste Blanchet of a specimen about ten miles from Morristown, in May, 1859. He says: 'The whole plumage resembles somewhat that of the female *H. chysoptera*, but the grayish on the breast is not so deep.' Mr. Thurber regards this bird as a hybrid.

'An Interesting Specimen of *Helminthophila*,' by William Brewster, Cambridge, Mass., *Auk*, Vol. III., No. 3, pp. 411–412, 1886. Records another specimen taken by Mr. Frank Blanchet two miles from Morristown, N. J., on May 15, 1884. The sex was not determined. Mr. Brewster writes of this specimen that it '* * * is apparently a hybrid between the hybrid *H. lawrencei* and the typical *H. pinus*.' After describing the bird with much detail he adds: "In briefer terms, this interesting bird may be said to be about intermediate in color and markings between typical *pinus*, with its short narrow eye-stripe and uniformly yellow underparts, and the so-called *H. lawrencei*, which has a broad black patch extending from the bill through and beyond the eye, and the chin, throat and forepart of the breast solidly black. It forms an important link in the chain of evidence supporting my theory (*Bull. Nutt. Orn. Club*, Vol. VI., No. 4, pp. 218–225, 1881) that *H. pinus* and *H. chrysoptera* frequently interbreed, and that their offspring perpetuate a variously characterized hybrid stock by breeding back into one or the other parent strains."

'The Significance of Certain Phases in the Genus *Helminthophila*,' by Spencer Trotter, M.D., *Auk*, Vol. IV., No. 4, pp. 307–310, 1887. Accepting the theory of hybridity, Dr. Trotter believes, because of its apparent common occurrence, as represented in the many specimens of *H. leucobronchialis*, that it indicates the degeneracy of the species producing this hybrid. He concludes, therefore, that the extinction of *chrysoptera* and *pinus* is in process, and perhaps imminent.

'Notes on Birds Observed in the Vicinity of Englewood, New Jersey,' by Frank M. Chapman, *Auk*, Vol. VI., No. 4, pp. 302–305, 1889. Mr. Chapman writes of *leucobronchialis* as 'this puzzling hybrid.'

Cf. Ridgway, 'Manual of North American Birds,' 1896, footnotes on page 486. Mr. Ridgway advances the dichroic theory plus hybridity to account for *lawrencei* and *leucobronchialis*.

good field ornithologists declare that they have seen either *Helminthophila leucobronchialis* or *H. pinus* attending young which they supposed to be *H. leucobronchialis*. And it is also on record that a parent *leucobronchialis* was observed with two young, feeding them. This bird was observed with these young ones two different days in the same locality. But two young composed the brood, and Dr. Bishop, who saw and collected them, writes: 'A careful search on both days through the adjacent country failed to disclose any other member of the genus *Helminthophila*.' He believed the parent bird to be a female and also concluded, though the two young were still in the down plumage of nestlings, from the final feathering that showed through, that: 'One, and probable that the other, would have become a typical specimen of *H. pinus*.'

These facts[10] would in themselves seem to controvert the theory of hybridity, for, though hybrids do occur among wild birds, they can

[10] 'Notes on *Helminthophila leucobronchialis*,' by Edwin H. Eames, Seymour, Conn., *Auk*, Vol. V., No. 4, pp. 427–428, 1888. Records the capture or observation of six adult and several young in a brood, between May 26, 1888, and June 22, of the same year, near Seymour, Conn. From this series of notes I quote Mr. Eames, writing of *H. leucobronchialis*, the date being June 3: "At last with more eagerness than usual it descended, and disappeared in the bushes (an unusual occurrence), where it apparently took possession of its nest, as in less than half a minute thereafter an *H. pinus*, the first I had seen in the neighborhood, flew hastily from about the same place. This occurred at about sunset, and between that and dark *leucobronchialis* did not again appear in sight. I had previously had it in view, or could hear its song, almost continuously. On several days following I searched this thicket thoroughly, as it seemed, and once succeeded in flushing a *pinus*, but could not even then find its nest. In company with *pinus*, *leucobronchialis* cautiously approached and surveyed me for a short time, then departed with no apparent misgivings. At all other times *leucobronchialis* was near by and always reconnoitered the track of my careful search when I had moved to some distance, then, apparently satisfied, pursued its avocations as before. I was not able to visit the spot again until June 17, and neither then nor since have I found this *leucobronchialis*, but I did find a brood of several young being fed by an *H. pinus*, possibly the result of a union between the two. These two birds were the only ones of the genus which I had at any time detected in the locality."

'Notes on the Blue-winged Warbler and its Allies (*Helminthophila pinus*, *H. leucobronchialis*, *H. lawrencei* and *H. chrysoptera*) in Connecticut,' by Edwin H. Eames, *Auk*, Vol. VI., No. 4, pp. 305–310, 1889. Speaking of the comparative abundance of *H. chrysoptera* and *H. leucobronchialis* in southern Connecticut, Mr. Eames writes: "Of *H. chrysoptera* but little can be said, as it is properly considered a rather rare bird here, and our yearly records are but few, usually less than half a dozen."

"The beautiful *H. leucobronchialis* is much (?) more common than the latter (*chrysoptera*) and is eagerly sought after by most of our collectors, latterly with good success considering its former (supposed) rarity." During the spring of 1889 he procured five specimens, and recorded the breeding of *leucobronchialis* as follows: "Mr. C. K. Averill, Jr., of this city, found a *leucobronchialis* early in June. * * * June 24 I accompanied him to the place and we soon had the pleasure of watching the bird at shorter range than I think has fallen to the lot of others, *i. e.*, three to ten feet. * * * It came to the same conspicuous clump of bushes and briar many times, with from one to five minutes' intermission, each time with one or more small worms, about three quarters of an inch long, first reconnoitering, then cautiously approaching, and again hastily leaving a part of this clump of bushes not over two feet in extent. We failed to discover the identity of the object of its cares, but I have reason to believe it was a young cowbird. The rest of this brood was being fed by the only *H. pinus* (a female) to be found in the neighborhood. * * * They showed a marked general similarity to the young of *pinus*. I shot this male *leucobronchialis* August 8 and also one of the young, carefully observing that the others were similar to the one killed, which was altogether too familiar with the adult bird to allow a possibility of doubt concerning its male parent.

"In this, as in many other species of our smaller birds, such an affection is shown for the haunts occupied during the nesting period that they rarely leave them until after moulting, or even till the commencement of the fall migration. In the above case I never failed to find the birds

be considered at best as only casual, and the infertility of hybrids, especially among the higher animals, is too well known to need further comment here. If it be conceded then as improbable that over one hundred cases of wild hybridity have occurred between *H. chrysoptera* and *H. pinus*, only one other conclusion can be reached, namely, that from one of these warblers (probably *H. pinus*) there began to occur 'mutations' that have increased in geometrical progression and have finally grown sufficient in number to become themselves a parent stock, though it seems probable that the 'mutations' are still occurring from the ancestral stock, as witness the observations of good field ornithologists alluded to above, who say they have seen *H. pinus* feeding young which they supposed to be *H. leucobronchialis.* They supposed the young to be *H. leucobronchialis,* because in every case one of the parents was *H. leucobronchialis,* but, on the other hand, in every case, one of the parents was an *H. pinus.* Now the cases where such conditions have prevailed are *five* in number. It is significant that while the generally accepted hypothesis to account for the origin of *H. leucobronchialis,* is that *H. chrysoptera* has crossed with *H. pinus,* the result being a hybrid, *H. leucobronchialis,* yet in no case has any naturalist asserted that he has seen *H. chrysoptera* feeding young supposed to be *H. leucobronchialis.*

I am aware that there are two cases[11] of the

within the bounds of a two-acre tract of land."

'On the Breeding of *Helminthophila pinus* with *H. leucobronchialis* at Englewood, New Jersey,' by Frank M. Chapman, American Museum of Natural History, New York City, *Auk*, Vol. IX., No. 3, pp. 302–303, 1892. Record of typical male *H. pinus*, breeding with non-typical female *H. leucobronchialis*. Description of nest and eggs. This pair of birds deserted the nest and further observation could not be made.

'Notes from Connecticut,' by E. H. Eames, Bridgeport, Conn., *Auk*, Vol. X., No. 1, pp. 89–90, 1893. Mr. Eames writes: "* * * while on the other side and within a stone's throw a beautiful Brewster's warbler spent the greater part of his time. The latter after patient watching revealed his mate, a blue-winged warbler, and a nest in course of construction. * * * When seen again, on June 14, it contained four eggs, two of which were cowbirds', which were removed. Those remaining brought forth a pair of birds that, as they left the nest, could not be distinguished from normal young of the female parent, as would be expected, whatever the color of the male."

'*Helminthophila leucobronchialis*,' by Louis B. Bishop, M.D., New Haven, Conn., *Auk*, Vol. XI., No. 1, pp. 79–80, 1894. "On July 1, 1893, I found an adult *H. leucobronchialis* with two young in a small tract of alder swamp and woodland of North Haven, Conn. They were little disturbed at my presence, and I watched them carefully for some time. The adult fed both young at short intervals, leaving little doubt of its relationship to them. On July 4 they were still in the same locality, and I collected all three. Possibly the remainder of the family had been killed, as a careful search on both days through the adjacent country failed to disclose any other member of the genus *Helminthophila*.

"Decomposition was so far advanced before I could prepare the adult that I was unable to determine its sex. The fact that it never sang while I was watching it, together with the generally dull color of its plumage, lead me to think it a female.

"Unfortunately both of the young were still principally in the olive, downy plumage of nestlings, but enough of the final feathering had appeared on the throat, breast and upper parts to make it certain that one, and probable that the other would have become a typical specimen of *H. pinus*. The wing-bars of the young differ, being in the most mature specimen narrow and almost white, and in the other broader and light yellow."

[11] 'Evidence concerning the Interbreeding of *Helminthophila chrysoptera* and *H. pinus*,' by A. K. Fisher, M.D., Sing Sing, N. Y. "On July 4, 1885, while collecting specimens in a piece of woods underlaid by a scattering undergrowth, I came upon a female golden-winged warbler busily engaged in collecting insects. As I stood watching her she flew to a neighboring cedar tree and commenced to feed a young bird. I immediately shot and killed the latter as the female flew away. The noise of the discharge started another young bird from some bushes near by, and as it flew the female flew and alighted near it. Just as I was on the point of firing they started,

mating of *H. chrysoptera* with *H. pinus*, but in the first of these, as will presently appear, the male parent is hypothetical. It is to be noted that in the first case Dr. Fisher found a female *H. chrysoptera* feeding a young *H. pinus* in a cedar tree. Upon the shooting of this fledgling the old female flew away; the shot startled another young bird from some bushes near by, and as it flew the female also flew and alighted near it and was then shot. The young bird that was killed 'was the exact counterpart of the blue-winged yellow warbler' (*H. pinus*), while the second bird carefully observed resembled the adult bird that was shot, and was, therefore, apparently a young *H. chrysoptera*. No male parent was seen nor were any other young observed.

and I succeeded in wounding the female only and had to follow and kill her with a second shot. On my return to the place where I first shot at her, I could not find the young one, nor did a careful search disclose it. In advancing for a nearer shot I had a good opportunity of seeing the young bird: it closely resembled its mother in appearance and had no yellow on the breast, whereas the one killed was the exact counterpart of the young of the blue-winged yellow warbler, with its yellow breast and white wing-bars. In all probability the father of this interesting family was a specimen of *Helminthophila pinus*."

This is the entire account of the incident. (W. E. D. S.)

'The Interbreeding of *Helminthophila pinus* and *H. chrysoptera*,' by John H. Sage, Portland, Conn. "On June 13, 1889, Mr. Samuel Robinson, who has collected with me here for the past fifteen years, noticed a male *Helminthophila pinus*, with food in its bill, fly and disappear at the foot of a small alder. A female *Helminthophila chrysoptera* soon appeared, also with food, and was lost to sight at the same spot as the other bird. On going to the locality five young birds flew from the nest and alighted on the bushes in the immediate vicinity. Both parent birds were soon feeding the young again. He shot the old birds and secured all the young, which, together with the nest, are in my cabinet.

"* * * The male (*pinus*) is a very bright specimen with white wing-bars, edged with yellow. The female (*chrysoptera*) is strongly marked with yellow below, the wing-bars being exceptionally rich with the same color.

"The young, two males and three females, are all similar, and have the head, neck, chest, sides and back olive-green. Abdomen olive-yellow. Remiges like adult *pinus*. Two conspicuous wing-bars of light olive edged with yellow."

This is the entire account of the incident, except a description of the locality, the nest and its situation. (W. E. D. S.)

Granting that both of these fledglings were the progeny of the bird seen feeding one and associated with the other, and also granting that the unknown male parent of both these young birds was *H. pinus*, neither of the young was *H. leucobronchialis*, the hybrid which it is asserted is the result of such a union.

The second case which is recorded by Mr. Sage goes on to state that a male *H. pinus* and a female *H. chrysoptera* were discovered feeding five young in a nest; these birds flew out of the nest on being approached, whereupon all seven were collected. The author says that the male was typical *pinus* and the female typical *chrysoptera*, 'strongly marked with yellow below.' The five young proved to be two males and three females and 'are all similar,' being olive green in color, becoming olive yellow on the abdomen and having the wings like young *pinus*. Surely these young are not *leucobronchialis*, and while the interbreeding of *chrysoptera* and *pinus* is hereby thoroughly established as a rare and casual occurrence, these hybrid young, the result of this union, so far as I can perceive, are a direct refutation of the hybrid theory, which attempts to account for the origin of *H. leucobronchialis*.

On the other hand, we have direct evidence that both *H. leucobronchialis* and the rarer *H. lawrencei* have mated and bred and reared young with *H. pinus*.

In view of the foregoing facts, I am of the opinion that in *H. leucobronchialis* and in *H. lawrencei*, presently to be considered, we have examples of two separate and distinct 'mutations' from a common parent stock or species. That is, I believe that *H. pinus*, early in the last century became unstable as

a species[12] and began to throw off what must be considered as 'mutants,' taking de Vries's definition of the word. In other words, *H. pinus* is alone responsible and is the direct ancestor of both *H. leucobronchialis* and *H. lawrencei;* that these 'mutants' have up to the present time generally bred back into the parent stock, and that in so doing the instability of *H. pinus* has increased geometrically with the constant result of the increasing number of both kinds of 'mutants.'

LAWRENCE'S WARBLER, HELMINTHOPHILA LAWRENCEI (HERRICK).

Previous to Mr. Brewster's description of *Helminthophila leucobronchialis,* Herrick described[13] a bird which he named *Helminthophila lawrencei.* The affinities of this species are evidently with *H. pinus,* which it resembles in many ways, but from which it differs in being bright olive green above, and in having the ear coverts black and an area on the throat the same color.

At the time of this writing, between twenty and twenty-five[14] specimens are known, there being some confusion as to three of them. These birds are generally believed to be hybrids or crosses between *H. pinus* and *H. chrysoptera.*[15] But no one has ever intimated that they have seen *lawrencei* mated with *chrysoptera,* or *chrysoptera* feeding young

[12] Cf. Bishop, *Auk,* Vol. XXII., No. 1, pp. 21–24, 1905. "In southern Connecticut there are three distinct forms of the blue-winged warbler (*H. pinus*) taking males alone into consideration—the ordinary form with rich gamboge-yellow lower parts, white wing-bars and bright olive-green back; a second form like the last but with gamboge-yellow wing-patch, resembling the golden-winged (*H. chrysoptera*), which is much the rarest; and third, a form with pale yellow lower parts, much paler back, and with usually yellow wing-bars; and between the three occur all sorts if intermediates.

[13] *Proceedings of the Academy of Natural Sciences of Philadelphia,* p. 220, plate 15, 1874.

[14] 'Description of a New Species of *Helminthophaga,* by Harold Herrick, *Proceedings of the Academy of Natural Sciences of Philadelphia,* 1874, p. 220, pl. 15.

'Capture of a Second Specimen of *Helminthophaga lawrencei,*' by Harold Herrick, *Bull. Nutt. Orn. Club,* Vol. II., No. 1, pp. 19–20, 1877. Records the capture of a second specimen which Mr. George N. Lawrence obtained from a dealer who told him that it was taken near Hoboken, N. J., in the spring of 1876. It was apparently a male and closely resembled the type.

'A Third Specimen of Lawrence's Warbler,' by Clark G. Voorhees, New York City, *Auk,* Vol. V., No. 4, p. 427, 1888. Records the capture at Rye, Westchester Co., N. Y., on August 31, 1888, of an adult male. The third known specimen.

'*Helminthophila pinus, H. chrysoptera, H. leucobronchialis* and *H. lawrencei* in Connecticut in the Spring of 1888,' by Louis B. Bishop, M.D., New Haven, Conn., *Auk,* Vol. VI., No. 2, pp. 192–193, 1889. Records the capture of three specimens: a female at New Haven, May 21, a female at Stamford, May 23, and a male at the same place on May 25. This makes six known specimens.

Cf. *op. cit., Auk,* Vol. I, No. 1, pp. 305–310. Records by E. H. Eames of the capture of an adult male at Bridgeport, Conn., on May 16, 1889, and hearing this bird in full song. This is the seventh one known.

'Notes from Connecticut,' by E. H. Eames, Bridgeport, Conn., *Auk,* Vol. X., No. 1, pp. 89–90, 1893. Mr. Eames records: 'Four Lawrence's warblers were within a radius of half a mile, three typical and one with the black obscured and the crown dull yellow-olive, * * *.' This brings the known number of this bird up to eleven.

'Notes on *Helminthophila chrysoptera, pinus, leucobronchialis* and *lawrencei* in Connecticut,' by John H. Sage, Portland, Conn., *Auk,* Vol. X., No. 2, pp. 208–209, 1893. Mr. Sage records a single example, a male taken on May 14, 1887. This is the twelfth known specimen.

'Notes Concerning Certain Birds of Long Island, N. Y.,' by William C. Braislin, M.D., *Auk,* Vol. XX., No. 1, pp. 50–53, 1903. "At Cold Spring Harbor, Long Island, May 8, 1902, a specimen of Lawrence's warbler was secured. * * * is a male, and seems perfectly typical." This appears to be the thirteenth bird of this kind recorded.

Cf. Thurber, *True Democratic Banner* (newspaper), Morristown, N. J., November 10, 17 and 24, 1887. Records a specimen.

[15] '*Helminthophila leucobronchialis,*' by Robert Ridgway, *Auk,* Vol. II., No. 4, pp. 359–363. Ridgway argues from the color pattern of the type and the second recorded bird (see above), and

that were like *lawrencei,* while, on the other hand, we have three records of the breeding of *lawrencei.*[16] First, a female feeding young (*it is to be noted in this case both parents were H. lawrencei*), the male having been shot just previously. There were six young in this brood, which was not further disturbed, and several of the nestlings, presumably young males, showed traces of black on the throat. Second, a female *H. lawrencei* discovered attending a brood of what appeared to be young *H. pinus.* The male parent was not seen. Third, a male *H. lawrencei* mated with a female *H. pinus,* both parents attending six young (in the nest) which resembled in plumage typical nestlings of *H. pinus.*

Moreover, the number of known specimens (plus twenty) is in itself an argument against the theory of hybridity difficult to overcome. As before stated, I believe that here again we have a mutation from *H. pinus,* which has not flourished to the extent that has *H. leucobronchialis.*

The next fifty years should go far toward telling the story in regard to both of these birds and it behooves *every good field naturalist not to add more specimens of these birds to our collections, but to carefully observe them as they exist, alive;* to make, if possible, a comparative census of them in given localities where they are of regular occurrence, and to do this annually for many years to come. Much light, too, may be thrown on their relationship by observing with greater care than has heretofore been given the parentage of *all* the different nests of *Helminthophila,* in any

an adult female taken at Highland Falls, N. Y. (cf. Brewster), that these three birds are hybrids between *H. chrysoptera* and *H. pinus.*

'The Coloration and Relationship of Brewster's Warbler,' by Gerald H. Thayer, Monadnock, N. H. Regards *H. lawrencei* as a hybrid between *H. pinus* and *H. chrysoptera* because of its color pattern and its rarity.

Cf. Bishop, *Auk,* Vol. XX., No. 1, pp. 21–24, 1905.

[16] 'Connecticut Notes,' by A. H. Verrill, New Haven, Conn., *Auk,* Vol. X., No. 3, p. 305, 1893. Mr. Verrill writes: "On May 6, 1893, * * * I procured an adult male Lawrence's warbler. May 31, I noticed a Lawrence's warbler which I thought was breeding. On June 5 I again noticed the bird and shot it, and, after hunting some time, I finally flushed the female from her nest which, unfortunately, contained six young birds. I had a very good chance to examine her as she was constantly within six or eight feet from me. The nest was in all respects precisely like that of the blue-winged warbler. The young birds were well feathered out, and several of them showed traces of black on the throat."

["The really unfortunate part of the affair seems to have been not that the writer was disappointed in his hopes of a set of eggs, but that he failed to capture and rear the young and to secure the female—that he threw away a rare opportunity of casting much light on the status of this doubtful species.—Eds." *Auk.*]

'Connecticut Notes,' by Clark Greenwood Voorhees, New York City, *Auk,* Vol. XI., No. 3, pp. 259–260, 1894. "On the 12th of July (at Greenwich, Conn.), while looking for *Helminthophila,* I took an adult female, *H. lawrencei.* The bird is in every way like the female *H. pinus,* excepting that the thoat patch and stripe through the eye, which in the male *H. lawrencei* are black, are in this specimen dusky olive-green. The specimen is quite similar to the one taken by Mr. H. W. Flint in New Haven several years ago.

"The young in first plumage which this bird was attending when shot was in every respect typical *H. pinus.* The male parent was not found, but I feel confident that it was *H. pinus,* as the young were well feathered and showed clearly well-defined black lores of the latter."

'Breeding of Lawrence Warbler in New York City,' by C. William Beebe, curator of ornithology, New York Zoological Park, *Auk,* Vol. XXI., No. 3, pp. 387–388, 1904. Mr. Beebe records the discovery of this bird breeding in the Bronx Park. The birds were observed from May 18 until June 16, 1904. The nest was discovered early in June. A male *H. lawrencei,* typical in appearance, was mated with a female which appeared to be a typical *pinus.* On June 13 *both parents* were observed feeding the six young in the nest. The observers were within eight feet of the birds at this time. The nestlings upon examination were all in the *typical nesting plumage* of *H. pinus,* and showed no traces of the black markings of *H. lawrencei.* Very wisely these birds were not disturbed or collected and it will be interesting to watch future developments in this locality.

territory where *leucobronchialis* and *lawrencei* occur.

Thus far I have dealt with North American birds, but there is an additional instance from Italy that demands attention in this connection. In the year 1900 Professor Henry Hillyer Giglioli described a supposed new species of owl which he named *Athene chiaradiæ*.[17] This bird was discovered alive in the possession of a shoemaker at Caneva di Sacile. Its origin was traced back to a shepherd boy, who said that he took it from a nest in a crevice in a stone wall. There were four nestlings in this brood. After a day or two all but one of the young escaped. The locality Pizzocco is on the Prealps of Friuli.

This little owl was plainly related to a species, *Athene noctua,* common in this region, but it differed in having 'the tone and the pattern or style of the coloration,' so notable as to at once distinguish it from its ally; moreover, it had *dark brown irides,* which appeared black in the living bird. This in itself is remarkable, inasmuch as all the owls of the genus *Athene* have yellow irides.

By the year 1903 nine similar owls had been secured or observed, but all of them were found in nests, where some of their brothers or sisters were the yellow-eyed *A. noctua.* The parent birds of at least two of the nine known representatives of *A. chiaradiæ* are known to be true *A. noctua.*

These nine records were only secured after infinite painstaking effort, and I quote part of Professor Giglioli's conclusions in his article in the *Ibis:*

"And now for an attempt to explain the very strange and novel case. Of course, after what is now known, my first supposition that *A. chiaradiæ* might have been one of the last survivors of a species on the verge of extinction falls to the ground. But the opposite hypothesis, that we have in this singular small owl a case of *neogenesis* —*i. e.*, the *exabrupto* formation of a *new type* with sufficient differential characters to constitute, if maintained, a *new species*—can, I believe, be upheld.

"The term *neogenesis* was first used to explain this sudden origin of new forms from old-established species, if I am not mistaken, by my friend and colleague Professor Paolo Mantegazza, many years ago; it has been since used, more or less in the same sense, by the late Professor Cope and by others. I have no intention here of making any attempt to explain the causes which may bring forth such a result; they are necessarily various and usually occult. Suffice it to say that without a strong perturbation of the force of heredity such primary causes would give no result.

"Now, if in the case of *A. chiaradiæ* we have indeed an instance of true neogenesis—and the divergence of the parent birds from the normal type of *A. noctua* in different directions would go some way to prove that in them the force of heredity had been disturbed—we have before us an *attempt* at the formation of a new species, a case of singular and intense interest. I can not but consider it as an attempt, so far, for it is very possible that the couple of somewhat anomalous *A. noctua* now dead—which generated in all probability the *four* and perhaps *eight A. chiaradiæ* born at Pizzocco, and which possibly may also have been the parents of the couple from which the specimen at Fregona (at no great distance) was born—were *alone* endowed with the faculty of generating the black-eyed form, and they can do so no more. Again, should any of their black-eyed offspring have survived or should the occult primary causes leading to this singular case of neogenesis yet exist, and should in northeast Italy or elsewhere individuals of *A. chiaradiæ* be again produced and be able to breed freely, we can not guess whether or not the force of heredity, regaining its full sway, may fix, so to speak, the differential characters of specific value which suddenly emerged in the first specimens of *A. chiaradiæ*, or else, turning back to an easy atavism, alter the black-eyed form again to the original yellow-eyed *A. noctua.*

"In the first case a *well-defined* and *remarkable* species would be established; in the second my *A. chiaradiæ* would disappear. In either case I opine that the name that I have given to the black-eyed civetta should be maintained, for it is of obvious scientific interest to save this important case from oblivion. It will require several

[17] H. H. Giglioli, 'Intorno ad una presunta nuova specie di *Athene* trovata in Italia,' in *Avicula,* IV., fasc. 29–30, p. 57 (Siena, 1900). Reprinted in 'Ornis,' XI., p. 237 (Paris, 1901).

'The strange case of *Athene chiaradiæ,*' by Henry Hillyer Giglioli, H.M.B.O.U., etc. *Ibid.,* Vol. III., 8th series, pp. 11–18, pl. I., 1903.

generations, under the most favorable hypothesis, viz., that more *A. chiaradiæ* be produced, to enable us to decide whether or not a new species of *Athene* has been formed.

"As to any other hypotheses to explain the formation of *A. chiaradiæ*, I can but repeat that I reject both that based on *hybridism*, and that of *a teratological* or *pathological* cause. Hybrids always show traces of the characters of both parents, especially when, as would be the case in *Athene*, of sheer necessity the connubium can not but occur with a species of such very distinct genera as *Nyctala*, *Scops* and possibly *Glaucidium*; now *A. chiaradiæ* is purely and simply an *Athene*, and shows no trace whatever of the characters, either specific or generic, of any of the forms quoted above. As to a teratological or pathological origin, a mere glance at one of the black-eyed civette will show that they can not owe their origin to such a cause. Besides in such cases, as again in hybrids, the form produced varies, and in these black-eyed descendants of *A. noctua* the specimens thus far examined are perfectly alike. The only instance in which we find perfect similarity in pathological descendants is in cases of absolute *albinism or melanism*, or, to put it better, in *monochroic* varieties.

"I believe that neogenesis gives a logical explanation of the strange case of *A. chiaradiæ*. But neogenesis, which appears to be of frequent occurrence amongst plants, has rarely been noted in animals, and I believe never before amongst vertebrata in a wild state.

"Finally, as I have said before, neogenesis may or may not lead to the establishment of a new species."

The conclusions arrived at by this eminent Italian naturalist, which have just been quoted at length, appeal to me strongly and force me to endorse the view he has so ably presented.

In the light of the evidence set forth only one answer can be made to the question as to the part that the process defined by de Vries as 'mutation' is playing among higher animals to-day. Beyond doubt we have witnessed the birth of new species of birds during the past seventy years. Moreover, some of these new species have flourished so as to have become a salient part of the bird fauna in the region where they occur and where they were unknown to skilled ornithologists, who carefully studied these regions in the early part of the last century.

WILLIAM E. D. SCOTT.
WORTHINGTON SOCIETY FOR THE INVESTIGATION OF BIRD LIFE.

BOTANICAL NOTES.

NORTH AMERICAN FLORA.

SOME years ago a group of American botanists under the leadership of Professor Doctor N. L. Britton proposed to undertake the preparation of a comprehensive botanical work which was to bear the name 'Systematic Botany of North America.' One part, consisting of a few pages, was issued, since which nothing further has appeared. Botanists everywhere will be much pleased to know that in this interval work has gone forward, and that publication has been resumed. The title is now 'North American Flora' (instead of 'Systematic Botany of North America'), and its scope has been considerably extended, so as now to include the whole of North America from Greenland to Panama and the West Indian Islands.

As projected the work will include thirty volumes, which are to appear in from 120 to 150 'parts.' The volumes have been assigned as follows: Vol. 1, Mycetozoa, Schizophyta, Diatomaceae; 2 to 10, Fungi; 11 to 13, Algae; 14 and 15, Bryophyta; 16, Pteridophyta and Gymnosperms; 17 to 19, Monocotyledons; 20 to 30, Dicotyledons.

The magnitude of the work may be estimated from the fact that the part before us includes eighty pages. It will be published by the New York Botanical Garden, through the aid of a fund bequeathed by Charles P. Daly. The first part issued (bearing date of May 22, 1905) is Part 1 of Volume 22, beginning with the order Rosales, under which are monographed the families Podostemonaceae (by G. V. Nash), Crassulaceae (by N. L. Britton and J. N. Rose), Penthoraceae and Parnassiaceae (by P. A. Rydberg). The descriptions are concise and the synonymy full. Type localities, distribution and illustrations are cited. Metric measurements are used exclusively. Keys to families, genera and species are given.

The printed page is large (123 by 200 mm.), and the type and arrangement, while so compact as to leave no waste space, are pleasing to the eye.

NEW EDITION OF BRITTON'S MANUAL.

THE second edition of Britton's 'Manual of Flora of the Northern States and Canada,' which appeared some months ago includes descriptions of about one hundred additional species in an appendix, bringing the total number up to more than 4,600. Generic and specific synonyms have been added in many instances, thus adding greatly to the usefulness of the book for working botanists. The addition of a number of artificial keys will be especially helpful to beginners.

A NEW TROPICAL FLORA.

J. R. JOHNSTON (Gray Herbarium of Harvard University) has in preparation a work on the 'Flora of the Islands of Margarita and Coche' off the north coast of Venezuela, which must prove of much interest to American botanists. In noticing his descriptions of new species from these islands some time ago, the authorship of this work was erroneously given in these columns.

THE TEACHING OF BOTANY.

IN a most suggestive book entitled 'The Teaching of Biology in the Secondary School' (Longmans, Green & Co.) by Professors Lloyd and Bigelow, the former discusses many matters connected with the teaching of botany. Calling attention to the advances which botanical science has made in America during the last twenty-five years, and the changes which the teaching of the subject has experienced, he insists that the teachers should come to their work 'with a special mental equipment for their peculiar tasks,' and full of knowledge of the problems which they will be called upon to face in their work. In the course of the author's discussion one finds such chapter headings as 'The Value of Science, and Particularly of Biology in Education'; 'Nature Study; The Value of Botany in Secondary Education'; 'Principles Determining the Content of a Botanical Course'; 'The Various Types of Botanical Courses'; 'Use of the Method of Thought in Teaching Botany'; 'General Botanical Principles to be Emphasized in Teaching'; 'Detailed Discussion of the Course in Botany for the High School'; 'The Laboratory, its Equipment, Materials for Study and for Demonstration'; 'Botanical Literature for the Use of Teachers and Students.'

It is impossible to summarize these chapters. They should be read from beginning to end by every young teacher, and by some who are no longer young. In passing it may be noted that the author is thoroughly and heartily a believer in 'nature study'; indeed, he is so much in earnest in its advocacy that he devotes a good many pages to criticism of many of the erroneous methods employed by some of its teachers. In discussing the types of botanical courses for high schools he says truly, "one of the big ideas which a student should get from the study of plant forms is that of evolution. He should have an opportunity of looking into the kind of evidence which underlies this idea." The 'Huxley and Martin method,' he says, 'was ordinarily that of verification, while the development of individual initiative in thought was largely ignored.' Agassiz's method of bringing the student into 'direct contact with some form, such as a starfish, and leaving him to find out things for himself without aid of any kind' is characterized as 'heroic treatment, which can not be employed generally.'

Not to attempt too much is insisted upon, and also that the botany of the beginner must include something of each of the greater divisions of the science. In elucidating these suggestions the author discusses in detail the work which may be taken up in the high school. After quoting the course of study recommended by the Committee on a College Entrance Option in Botany, of the Society of Plant Morphology and Physiology, he details a course of his own, beginning with morphology and anatomy of the fruit and seed, and following this with ecology, field work, physiology, the root, the shoot, the leaf, the bud, Myxomycetes, Schizophyta, Thallophyta, Bryophyta, Pteridophyta, Phanerogams, geographical botany and physiographical plant ecology. In practise it will be found quite

impossible to cover this work in the time allotted to botany in the secondary schools, but tnere can be no doubt as to the high value of these suggestions, from which the teacher may well make such selections as his time may permit.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

CURRENT NOTES ON METEOROLOGY.

FOEHN WINDS IN THE ANTARCTIC.

DURING the Antarctic voyage of the *Discovery,* warm southerly winds were observed which, because of their high temperature, have generally been regarded as of *foehn*-like character. Sir Clements Markham (*Geogr. Journ.,* June) believes that the high temperature may result from the fact that these winds blow from the ocean beyond the pole, that is, Weddell Sea, and not from adiabatic warming during descent. Hence he thinks that the Great Barrier may end on the other side of the pole with another line of ice-cliffs facing the Weddell Sea, and that the winds may blow across the ice barrier with great velocity without lowering their temperature. On the other hand, Dr. W. N. Shaw suggests that the snow which comes with these warm southerly winds is carried along in a surface drift, and notes that intensely cold air can contain very little moisture.

LOW TEMPERATURE IN THE SAHARA.

IN the *Meteorologische Zeitschrift* for June, 1905, there is a note on some low temperatures observed on December 19, 1904, in the Sahara, between Tuggurt and Guerrara. The temperature at midnight was 30.2° Fahr.; at daybreak (6:15 A.M.), 28.4°; at sunrise (7:15 A.M.), 33.8°; at 2:30 P.M., in the shade, 75.2°; at 7 P.M., 41.0°; and at 8:30 P.M., 39.2°. It was calm, and the sky was clear. On December 20, at 7:30 P.M., the temperature was 33.8°, and there was heavy frost, which in places reached a thickness of 1 cm.

NOTES.

Das Wetter for June, 1905, contains an interesting article, of a 'popular' nature, entitled 'Aus dem Leben der Wolken,' by Dr. A. de Quervain; also a discussion, illustrated by means of curves, entitled 'Temperaturen auf Bergstationen und in der freien Atmosphäre, by Dr. W. Wundt.

THE *Annuaire météorologique* of the Royal Observatory of Belgium contains a useful list of text-books of meteorology, prepared by J. Vincent. Special attention is paid to *general* treatises, but a considerable number of special works on marine, medical and agricultural climatology are included. The list begins with Aristotle, and includes books in Latin, Greek, English, French, German, Italian, Dutch, Russian, Danish, Spanish, Hungarian, Norwegian and Portuguese.

THE mechanism of the origin of rain-clouds, and the conditions of heavy rains and floods on the northern slope of the Pyrenees, were discussed by Marchand, Director of the Pic du Midi Observatory, before the Congrès du Sud-Ouest Navigable, held at Bordeaux in June, 1902. The paper was printed in the proceedings of that congress, and a German translation of a portion of the article, in the *Meteorologische Zeitschrift* for June, 1905, makes this interesting study accessible to the general reader.

RECENT publications on the meteorology of the free air are those of Teisserenc de Bort, on the diurnal changes in temperature (*Comptes rendus,* Vol. cxl., 1905, 467) and of Hergesell, on the results obtained by means of kites over the Mediterranean Sea and Atlantic Ocean in 1904 (*ibid.,* January 30, 1905).

R. DEC. WARD.

ANNUAL REPORT OF THE COUNCIL OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE annual report of the council for the year 1904–5 states that the arrangements for the meeting of the association in South Africa had been directed, under the sanction of the council, by a special South African committee, sitting in London, and consisting of the general officers of the association (the president and president-elect, the general treasurer and the general secretaries), Professor Armstrong, Dr. Horace Brown, Sir William Crookes, Sir

James Dewar, Sir Archibald Geikie, Professor H. A. Miers, Sir Henry Roscoe and Dr. Sclater. The coordination of the work of the various local committees had been carried out under the direction of the central organizing committee for South Africa, sitting at Cape Town, consisting of Sir David Gill (chairman) and Dr. J. D. F. Gilchrist (secretary). An additional expenses fund having been opened to supplement the subvention of £6,000 from the South African colonies, contributions amounting to £3,100 had been received.

The following agreement has been made between the British Association and the South African Association in the matter of financial arrangements respecting the annual meeting in 1905: (1) That all members (but not associates) of the South African Association shall be entitled to associates' tickets at the meeting of the British Association in South Africa in 1905; (2) that the South African Association shall pay a contribution of £500 to the funds of the British Association; (3) the South African Association guarantees the purchase of a thousand copies at least of the annual volume, the copies to be sent direct to the members of the South African Association on payment to the British Association by the South African Association of the sum of 8s. per copy.

A committee of the council, consisting of Professor G. H. Darwin, Sir A. Geikie, the general secretaries and the general treasurer, was authorized to consider the appointment of an assistant secretary, in succession to Dr. Garson, resigned, with the result that Mr. A. Silva White was unanimously appointed to fill that office.

The books and other publications presented to or received in exchange by the association, with the exception of the publications of the corresponding societies of the association and the annual volumes of reports of the various Associations for the Advancement of Science, have been transferred to the Library of University College, Gower Street, the council of University College having undertaken to give the same facilities to members of the British Association for the use of University College Library as were granted under similar circumstances by the University of London.

The council also reported on a plan for dealing with the meteorology of the British colonies and the relation of the association to corresponding societies.

SCIENTIFIC NOTES AND NEWS.

THE American Anthropological Association is meeting this week at San Francisco under the presidency of Dr. Frederic Ward Putnam, of Harvard University and the University of California. The preliminary program contains the titles of thirty-nine papers, which proves that the anthropologists at least can hold an unusually successful meeting in the summer and on the Pacific Coast. We hope to print subsequently abstracts of the papers.

MR. W. R. DUNSTAN, F.R.S., director of the scientific and technical department of the Imperial Institute; Mr. F. W. Dyson, F.R.S., chief assistant at the Royal Observatory, Greenwich, and Dr. R. T. Glazebrook, F.R.S., director of the National Physical Laboratory, have been elected members of the council of the British Association.

THE regents of the University of California have granted a year's leave of absence to Professor Wm. E. Ritter, of the department of zoology, for research at the San Diego Marine Biological Station and travel abroad. Associate Professor Charles A. Kofoid will have charge of the department in his absence. Mr. C. O. Esterly, Mr. L. Griggs and Dr. Alice Robertson have been appointed assistants in zoology.

MR. GEORGE K. CHERRIE, of the Museum of the Brooklyn Institute, has just returned from South America, where he has been collecting for that institution. He obtained about 800 bird skins representing very fairly the avifauna of the region about Ciudad Bolivar, Venezuela. These include a fine series of the Hoatzin, together with nests and eggs of that bird; skins and skeletons of the Guacharo bird, and skins of a number of species of South American herons. From the observations of Mr. Cherrie, it seems probable that the breeding of the hoatzin is largely influenced

by the condition of the water, and inland, away from the influence of tide water, they do not breed until the ground beneath their nests is flooded. For this reason, although Mr. Cherrie stayed until June, he only obtained eggs of this bird. Eggs of a number of other species of birds were also obtained, many of which are but little known.

Mr. Edward W. Berry, the paleobotanist and secretary of the Torrey Botanical Club, is engaged in studying the fossil flora of Maryland for the Geological Survey of that state. Correspondents are requested to address him after September 1, in care of the Maryland Geological Survey, Johns Hopkins University, Baltimore, Md.

Mr. Gerald Dudgeon has been appointed by the secretary of state for the British colonies to examine and report upon questions relating to the development of the agricultural resources of British West Africa.

Dr. Oliver E. Glenn, acting professor of mathematics at Drury College, has been appointed a member of the editorial staff of the *American Mathematical Monthly,* succeeding Dr. Saul Epsteen, who has been called to the University of Colorado.

Professor J. Volhard, professor of chemistry at Halle, celebrated on August 6 the fiftieth anniversary of his doctorate.

The trustees of the British National Portrait Gallery have purchased a portrait of Tiberius Cavallo, 1746–1809, one of the earliest students of electrical science.

We learn from the New York *Evening Post* that the city of Nuremberg, in conjunction with the Society of German Clockmakers, has erected a monument by way of commemorating Peter Henlein, who, four hundred years ago, substituted springs for weights in clocks, and thus made watches a possibility. The statue was made by the Berlin sculptor Meissner. It represents Henlein at work in his shop.

In connection with the indication by the council of houses in London which have been the residences of distinguished individuals, a memorial tablet was on August 14 erected on No. 34, Gloucester Square, Hyde Park, where Robert Stephenson, the great engineer, resided at one time. The tablet is of encaustic ware and terra-cotta in color.

Dr. Otto Herz, the entomologist of St. Petersburg, has died at the age of fifty-six years. The deaths are announced of the Rev. Dr. J. Keith, of Scotland, who took an active interest in natural history, and of Mr. W. E. Langdon, a past president of the British Institution of Electrical Engineers.

We recorded last week the death of Professor Leo Errera. A correspondent writes in regard to him: "Errera was one of the comparatively few rich men who work as hard at science as do those who earn their living by teaching and research. A multi-millionaire, he earned the rather hard degree of Docteur Agrégé, and since his student days has been an important factor in the class-room and research work in botany at Brussels. His most notable work as an investigator, perhaps, was his demonstration that fungi store food reserves in the form of glycogen, like animals, and the contributions from his laboratory have been chiefly along physiological and ecological lines. Notwithstanding this limit to the field of his more active contributions, however, he was interested in all branches of botany, and at the recent International Congress at Vienna, where he secured a decision to hold the next quinquennial session at Brussels, he was one of the most constant and interested attendants at the arduous—and perhaps thankless—nomenclature sessions.

The correspondent of the London *Times* in Cape Town cabled on August 18 that the first boat, conveying a portion of the visiting members of the British Association to Durban, and marking the conclusion of the business program in Cape Town, would leave that night. It was obvious at the outset that a rivalry was established between the purely pedagogic portion of the program and that part which makes for first-hand knowledge of South Africa. Fortunately there is no tendency to gauge the success of the 1905 meeting by the attendance at the lectures. So far the attendance has not been striking, but it is felt that

that has been more than made up by the keenness of the members to see all that can be seen of the country, and to profit by a closer acquaintance with its problems, which is essential to the proper understanding of them in England. South Africa, while paying a tribute to the high standard of the papers read, will endorse whole-heartedly the policy adopted by the members.

THE Committee of the British Association on Zoology Organization has reported that a register of zoologists has been established, and that fifty-seven zoologists have accepted the invitation of the committee to place their names upon the register. The committee has obtained by correspondence the opinion of a large number of the zoologists of the country upon the question of the importance of the grant applied for by the committee of Section D to enable a committee to send a competent investigator to the Zoological Station in Naples. Other matters affecting the interests of zoologists in the country have engaged the attention of the committee during the year. A meeting of the committee was held in London on May 11. A meeting of zoologists summoned by the committee to consider the question of the teaching of natural history in schools was held in the Zoological Gardens, London, on the same date.

AT the last monthly meeting of the Zoological Society of London it was stated that the additions to the society's menagerie during that month had amounted to 274, amongst which special attention was called to a leopard (*Felix pardus*), from near Hong-kong, presented by Mr. J. A. Bullin; to the three Californian sea lions (*Otaria gillespii*), from Santa Barbara, purchased; to a white-tailed gnu (*Connochœtes gnu*), born in the menagerie; and to a male Somali ostrich (*Struthio molybdophanes*), purchased.

IT is expected that within a year wireless telegraph communication will be established between New Zealand and Australia.

THE *Journal of the American Medical Association* states that, at the request of the medical directors of the City Hospital, the board of public service adopted a resolution that hereafter the professor of pathology of the Cincinnati University shall be the head of the pathologic department of the hospital. The directors stated that they had been made convinced of the fact that a professorship of pathology would soon be added to the university staff.

THE Sanitary Inspectors' Association met in London on August 18. In the course of his presidential address, as reported in the London *Times*, Sir J. Crichton-Browne dealt with the housing problem, and pointed out the advantages from a health point of view of country life as compared with town life. That the townsman was shorter-lived than the countryman was, he said, incontrovertible. Professor Karl Pearson, a thoughtful and cautious anthropologist, had told us that decadence of character and of intelligent leadership was to be noted alike in the British merchant, the professional man and the workman, and this he attributed to the fact that the intellectual classes were not reproducing their numbers as they did 50 or 100 years ago. In this view Professor Pearson was supported by the prime minister, who said at Cambridge last year that in the case of every man who left the laboring class and became a member of the middle or wealthier classes his progeny were likely to be diminished owing to the fact that marriages were later in that class. He was inclined to think, however, that intellectual decadence, if it be upon us, was not altogether due to the causes assigned by Professor Pearson and Mr. Balfour, and was not necessarily destined to deepen as time went on. In a people like our own there was always outside the actually intellectual class a still larger class potentially intellectual with abilities incompletely evolved, because never called forth, but capable under stress of circumstances of the higher development. Many of our finest intellects had sprung from the unintellectual class, and genius was generally more or less of a sport. His own view was that any dearth of ability from which we might be suffering was to be ascribed not so much to the infertility of the cultivated classes as to the artificial production of stupidity in various ways, and to the incessant drainage from the country—which was the fit and

proper breeding place and rearing ground of intellect—of the best elements of our people to be swallowed up or deteriorated in our big towns. Not less untenable than the notion that the agricultural laborer was dull of intellect was the idea that the city urchin was cleverer and better endowed mentally than the little yokel. The rule seemed to be that the mental development of children was hastened by city life, but soon stopped short. Up till thirteen or fourteen years of age they were precocious and then came to a standstill. City life at its best was bad for children, involving, as it did, early puberty, exciting distraction, superficiality of knowledge, insufficient repose and the want of soothing influences that the country afforded; and at its worst, when it meant a tight squeeze in squalid dwellings, poor food, foul air, contact with vice and manifold temptations, it was utterly demoralizing. It seemed obvious that, if the city went on growing at the nineteenth century rate, and under nineteenth century conditions, it would dry up the reservoirs of strength in the population and leave an immense proletariat of inferior quality and without commanders.

UNIVERSITY AND EDUCATIONAL NEWS.

Moses A. Dropsie, of Philadelphia, formerly president of Gratz College, has bequeathed about $600,000, for the endowment of a college for the study of Hebrew literature and Rabbinical learning in that city. There are to be no restrictions in admission as to creed, sex or color.

The Department of Chemistry of Washington and Lee University is being reequipped this summer in new quarters. In all fourteen rooms will be occupied, nearly the whole of the old main building of the university being given over to the departments of chemistry, geology and biology.

Logan Hall, containing the anatomical and surgical departments of the University of Pennsylvania, was burned on August 14, entailing a loss of about forty thousand dollars. Many microscopes were destroyed.

We learn from *Nature* that probate has been granted of the will of Mr. John Innes, of Merton, Surrey, who died on August 8, 1904, leaving the sum of about £200,000 for public and charitable purposes. Among other bequests he left his house, the Manor Farm, Merton, and two acres of ground, "to establish thereon a school of horticulture or such other technical or industrial institution as the law will allow, to give technical instruction in the principles of the science and art of horticulture and the necessary physical and mental training incidental thereto; to erect suitable buildings and furnish them, and to provide workshops, tools, plant, scientific apparatus, libraries, reading-rooms, lecture and drill halls, a swimming bath and gymnasium. If this may not be legally carried out, then to establish in these buildings a public museum for the exhibition of collections of paintings and similar works of art, objects of natural history, or of mechanical or philosophic inventions, and to lay out land for a park."

The Draper's Company has made a further grant of £5,000 for an extension of the premises of the East London Technical College.

The University of Melbourne has received a largely increased endowment from the government of Victoria on condition of instituting a course for a degree in agriculture. The necessary arrangements for such a course have now been made, and the university is inviting applications in England and America for a professorship of botany and a lectureship in biochemistry in connection with the school of agriculture. A new professor of anatomy is also to be appointed for the medical school.

Mr. S. Herbert Cox has been appointed to the professorship of mining at the Royal School of Mines, South Kensington, vacant on the death of Sir Clement le Neve Foster.

Mr. Edward Ward, who has held the professorship of surgery in Leeds for the past six years, has resigned and will be succeeded by Mr. Harry Littlewood.

Dr. Richard Willstäter, associate professor of chemistry at Munich, has resigned.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, SEPTEMBER 8, 1905.

CONTENTS.

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE ADVANCE IN OUR KNOWLEDGE OF THE CAUSATION AND METHODS OF PREVENTION OF STOCK DISEASES IN SOUTH AFRICA DURING THE LAST TEN YEARS.[1]

I.

TEN years ago, when I first came to South Africa, I was led to take an interest in the various great stock diseases which do so much damage and so retard the progress of South Africa as a stock-raising country. I thought, therefore, that a good subject for my address, in the center of the foremost stock-raising colony of South Africa, would be a review of the work done in advancing our knowledge, during the last ten years, of the causation and methods of prevention of stock diseases in South Africa.

South Africa is particularly rich in animal diseases, every species of domestic animal seemingly having one or more specially adapted for its destruction. Now it is evident that, in an address of this kind, it will be impossible to take up every stock disease, but I think you will agree with me that those shown on this table are among the most important: East coast fever; ordinary redwater or Texas fever; biliary fever of horses; malignant jaundice of dogs; nagana or tsetse-fly disease; trypanosomiasis of cattle; rinderpest; horse-sickness; catarrhal fever in sheep; heart-water of sheep, goats and cattle.

Now we may group these diseases in vari-

[1] Address of the president of the Physiological Section of the British Association for the Advancement of Science, South Africa, 1905.

ous ways; for example, as below, where they are divided into two main divisions: *A* division, in which the parasite is known; and *B* division, in which the parasite is unknown.

A. PARASITE KNOWN.

I. Diseases caused by parasites belonging to the genus *Piroplasma:* (1) East coast fever (Koch), *P. parvum;* (2) Redwater or Texas fever, *P. bigeminum* (Theiler); (3) Biliary fever of horses, mules and donkeys, *P. equi;* (4) Malignant jaundice of dogs, *P. canis.*

II. Diseases caused by parasites belonging to the genus *Trypanosome:* (1) Nagana or tsetse-fly disease, *T. brucei* (Bradford and Plimmer); (2) Trypanosomiasis of cattle, *T. theileri* (Bruce).

B. PARASITE UNKNOWN.

I. Rinderpest.

II. Horse-sickness. Catarrhal fever of sheep; heart-water of sheep, goats and cattle.

I. DISEASES CAUSED BY PARASITES BELONGING TO THE GENUS PIROPLASMA.

1. *East Coast Fever.*

The first important stock disease I would draw your attention to, then, is east coast fever. This name was given to it by Professor Robert Koch, of Berlin. In the Transvaal the disease is usually called Rhodesian redwater. This term is not a good one, since the disease is not restricted to Rhodesia, nor did it arise there, nor is this a disease similar to the ordinary redwater. Ten years ago, when I first came to South Africa, east coast fever was unknown in the Transvaal. The first known outbreak occurred only some three and a half years ago, when it broke out at Koomati and Neilspruit, in the Barberton district, and in the east of the colony. The disease had broken out some time previously in Rhodesia, and the outbreaks in both colonies were due to infection from Portuguese territory. Although this disease has only been introduced to the country during the last few years, it has already produced an enormous amount of damage among stock, and is probably the most dangerous disease that the people of the Transvaal have to cope with at the present time, and for some years to come.

In the Annual Report of the Transvaal Department of Agriculture there is a most excellent report by Mr. Stockman, the then principal veterinary surgeon, on the work of the veterinary division for the year 1903–1904. A large part of this report is given up to east coast fever, and I must here express my indebtedness to Mr. Stockman for much of the following account of this disease. In the same annual report there is also an account by Dr. Theiler, the veterinary bacteriologist, of the experimental work. Messrs. Stockman and Theiler evidently worked together, and I must congratulate them on the immense amount of good, useful work done by them, and I would also congratulate the government on having had the services of two such accomplished and energetic gentlemen during the late troublesome times. Unfortunately for the Transvaal, Mr. Stockman has accepted the post of veterinary adviser to the board of agriculture in England, but I have no doubt his successor, Mr. Gray, from Rhodesia, will continue the good work begun by him.

East coast fever was first studied by Professor Koch at Dar-el-Salaam, in German East Africa, and he at first mistook it for ordinary redwater. It seems to occur as an endemic disease along a great part of the east coast of Africa, but appears to be restricted to a narrow belt along this coastline. The cattle inhabiting this region have become immune to the disease, and are, therefore, not affected by it. Cattle passing through the coast district to the interior, or brought to the coast district from the interior, are apt to take the disease and die. It was by the importation of cattle, therefore, which had passed through the

dangerous coast district that the disease was introduced into Rhodesia and into the Transvaal. On this map which I throw on the screen I have marked out the probable endemic area of this disease, and in the next slide the present distribution of the disease in the Transvaal is also marked out.

Nature of the Disease.—This disease only attacks cattle, but in them is an exceedingly fatal malady; in every hundred cattle attacked only about five recover from the disease. The duration of the disease after the first symptoms have occurred is about ten days.

The cause of the disease is a minute blood parasite called the *Piroplasma parvum* (Theiler). This parasite lives in the interior of the red blood corpuscles.

I now throw on the screen a representation of the blood from a case of Rhodesian redwater, magnified about a thousand times, showing these small piroplasmata in the interior of the red blood corpuscles. As in the case of so many of these blood diseases, the parasite causing it is carried from the sick to the healthy by means of a blood-sucking parasite. In this particular disease the tick which most commonly transfers the poison or living parasite from one animal to another is known as the 'brown tick,' *Rhipicephalus appendiculatus.* Koch supposed that the common 'blue tick' was the agent. The credit belongs to Dr. Lounsbury and Dr. Theiler of having shown that it is chiefly the 'brown tick' which acts as carrier; but Theiler has proved that *R. simus* is also able to transmit the disease. Without the intervention of a tick, as far as we know at present, it is quite impossible that the parasite of this disease can be transferred from one animal to another. For example, if we take a quantity of blood containing enormous numbers of these piroplasmata, and inject it into the blood circulation of a healthy animal, the latter does not take the disease. In the same way, if cattle affected by east coast fever are placed among healthy cattle in a part of the country where none of these 'brown ticks' are found, the disease does not spread. It is evident, therefore, that some metamorphosis of the parasite must take place in the interior of the tick, and this new form of the parasite is introduced by the tick into a healthy animal, and so produces the disease. In this particular disease the virus or infective agent is not transmitted through the egg of the tick, as is the case in some of these parasitic diseases, but only in the intermediate stages of the tick's development; that is to say, the larva which emerges from the egg of the tick is incapable of giving the disease. What happens is this: the larva creeps on to an infected animal and sucks some of its blood. It then drops off, lies among the roots of the grass, and passes through its first moult. The nympha, which is the name given to the creature after its first moult, is capable of transferring the disease to a healthy animal; that is to say, if it crawls on to a healthy animal and sucks blood from it, it at the same time infects this healthy animal with the germ of east coast fever. In the same way, if a nympha sucks infected blood from a sick animal, it is able, after it has moulted into the adult stage or imago, again to give rise to the disease if placed, or if it crawls, upon a healthy animal.

The Life-history of the Brown Tick.—I throw on the screen a slide representing the four stages of the life-history of the brown tick: The egg, the larva, the nympha and the adult or imago. The eggs are laid on the surface of the ground by the adult females, who deposit several thousand at a time; and these hatch out naturally, if the weather is warm and damp, in twenty-eight days. But this period of incubation of the

eggs may vary very greatly owing to differences in temperature. Immediately after the larva is born it crawls to the summit of a blade of grass or grass stem, and there awaits the passage of some animal. If an ox passes by and grazes on the grass, the tick at once crawls on to the animal, and, having secured a favorable position, starts to suck the ox's blood. It remains on the ox for some three or more days, when, having filled itself with blood, it drops off and lies among the grass. The first moult, under favorable conditions, takes twenty-one days, when the nympha emerges. In the same way the nympha crawls on to an animal and fills itself with blood. As a nympha it also remains on the animal for about three or four days. It again drops off into the grass, and at the end of eighteen days emerges from its second moult as the perfect adult male or female. The males and females again crawl on to an ox, where they mate. After this the female tick ingests a large quantity of blood, which is meant for the nourishment of the eggs, and again drops off, sometimes as early as the fourth day, into the surrounding grass. After about six days she lays her eggs in the ground, and the cycle begins again.

These ticks are very hardy, and in the intermediate stages can resist starvation for long periods, so that a larva or nympha or adult tick may remain perched at the end of a blade of grass for some months without finding an opportunity of transferring itself to a suitable animal. On this account it comes about that even if all infected cattle are removed from a field the ticks in that field will remain capable of transferring the infection to any healthy cattle which may be allowed into this field for a period of about a year. At the end of a year or fifteen months, however, the infective ticks are all dead, and clean cattle may be allowed into the field without any risk. If one takes these facts into consideration it will be seen that a single ox may spread this disease for a distance of some 200 miles, if trekking through the country at the average rate of ten miles a day. For example, an ox is infected by a tick; for fourteen days the animal remains apparently perfectly well; it has no signs of disease, nor has it any fever. It is capable of doing its ten miles' trek a day. At the end of fourteen days the temperature begins to rise, and the animal begins to sicken with the disease, but for the next six days the ox is, as a rule, able to do its ordinary day's march. During most of this time the brown ticks have been crawling on to this ox, becoming infected, and dropping off every three or four days. It can readily, therefore, be seen how much mischief a single infected animal can do to a country between the time of its being infected by the tick and its death some twenty-four days later. As a matter of experience, however, the disease has never been found to make a jump in this way of more than fifty or sixty miles, as, of course, it is very rare that a transport carrier will take his oxen more than that distance during the twenty days.

At the present time it may be said that there are about 500 infected farms in the Transvaal. During last year some 15,000 cattle died of the disease, and in the affected districts it may be said that there are still some 30,000 cattle alive. When one considers the value of the cattle dead of this disease, which may be said to be about £200,000, it is evident that money spent on the scientific investigation of the causes and prevention of stock diseases is money well spent. I am informed that all the South African governments are cutting down their estimates this year, and are inclined to reduce their veterinary staffs and the amounts devoted to research regarding

animal diseases. Ladies and gentlemen, if this is so, I have no hesitation in saying that this is the maddest sort of economy and the shortest-sighted of policies.

Methods of Combating the Disease.—During the last three years an immense amount of work has been done in the elucidation of this disease—how the animals are infected, how the poison is spread from the sick to the healthy, and so on. In 1903 Professor Koch was asked by the South African colonies to study this disease, in order to try to find some method of artificial inoculation or some other means of prevention. He did his work in Rhodesia, and especially directed his energies towards discovering some method of preventive inoculation. At first it was thought that he would be successful in this quest, as in his second report he announced that he had succeeded in producing a modified form of the disease by direct inoculation with the blood of sick and recovered animals. As you are all aware, the only method of conferring a useful immunity upon an animal is to make it pass through an attack of the disease itself, so modified as not to give rise to above a few deaths in every hundred inoculated. This is the method that has been employed in such diseases as rinderpest, anthrax, pleuro-pneumonia and many other diseases. The great difficulty in this disease in finding a method of preventive inoculation is the fact that the blood of an affected animal does not give rise to the disease in a healthy one when directly transferred under the skin of the latter. It is only after its passage through the body of the tick that the parasite is able to give rise to the disease in a healthy animal. It is evidently, on the face of it, difficult to so modify the parasite during its sojourn in the tick's body as to reduce its virulence to a sufficient degree.

Professor Koch in his third and fourth reports recommended that cattle should be immunized by weekly or fortnightly inoculations of blood from recovered animals, extending over a period of five months. Even though this method of Koch had given the desired result, viz., that it rendered the inoculated cattle immune to the disease, it is evident that the method itself can hardly be made a practicable one on a large scale in the field. The expense and trouble of inoculating cattle on twenty different occasions would be very great. It is apparent now that Professor Koch fell into error through mixing up east coast fever with ordinary redwater. His plan of preventive inoculation was, however, tried on a large scale in Rhodesia by Mr. Gray, now the principal veterinary surgeon, Transvaal, and found to be useless. At present, therefore, we must look to some other means of preventing the disease and driving it out of the country than preventive inoculation.

Dipping.—Much can be done to prevent the spread of this disease by ordinary methods. For example, in the case of Texas fever in Queensland dipping cattle in solutions of arsenic or paraffin, in order to destroy the ticks, has met with very fair success; but in the case of this disease we can not expect to get as good results as in the case of redwater. The species of tick which conveys Texas fever remains on the same animal through all its moults, instead of falling to the ground between each different one. If it is not possible to spray or dip cattle oftener than once in ten or fifteen days, it is evident that ticks may crawl upon such animals, become infected, and drop off every three or four days, and so escape destruction by the dipping solution. At the same time every infected tick that is killed by spraying or dipping operations is a source of infection destroyed.

Fencing of Farms.—Again, the fencing

of farms must also be useful in the same direction. As the ticks do not travel to any extent when they fall among the grass, it is evident that the cattle on a clean farm which is properly fenced will not become infected by this disease, although all the country round about should be infected. This fencing of farms and subdividing the farm itself into several portions is a most important factor in the prevention of contagious diseases amongst stock. It is, of course, impossible that this can be done at once, as the expense would be prohibitive.

Moving Cattle from Infected Pasture to Clean Pasture.—From a study of this disease and a study of the life-history of the tick it is evident that by a combination of dipping or spraying the cattle so as to destroy almost all the ticks, slaughtering the sick, and moving the apparently healthy on to clean veld—and repeating this, if necessary, a second or third time—it is obvious that by these means, if circumstances are favorable, an outbreak of this disease may be nipped in the bud without much loss to the stock.

Stamping out the Disease.—In May, 1904, an inter-colonial conference held at Cape Town resolved that the only effective method of eradicating east coast fever is to kill off all the cattle in the infected areas, and to leave such areas free of cattle for some eighteen months. By this means all the centers of infection would be destroyed, and at the end of eighteen months, as all the infected ticks would be dead, it is evident that the disease would be completely stamped out. There is no doubt that this drastic method would be the quickest and most complete one of getting rid of this extremely harassing disease. If compensation were given, it could be done at a cost of, say, a quarter of a million. The government decided, however, that on account of the difficulty of carrying out such a drastic scheme another policy had to be considered. This policy provides for the fencing-in of infected farms, places, lands or roads, on generous terms; the compulsory slaughter of stock with compensation in the case of isolated outbreaks; the removal of all oxen from infected or suspected farms; and, lastly, the stabling of milch cows in infected areas. It is quite evident that under this less drastic policy the final stamping-out of the disease will be a much slower process than if the more drastic scheme of compulsory slaughter of all cattle on infected areas had been carried out. The benefits, however, from the modified scheme are undoubted; and if carried out thoroughly and intelligently for a period of several years will probably result in the stamping-out of the disease.

Allow me to sum up in regard to the advance in our knowledge of this important stock disease during the last ten years. Ten years ago nothing was known. Now the causation of the disease has been made out very fully; the parasite that causes it is known; the ticks which carry the infection are known. Although no method of conferring immunity on healthy cattle has been found out, or any medicinal treatment discovered which will cure the sick animal, yet our knowledge of the life-history of the parasite and the tick enables regulations to be framed which, if patiently carried out, must be crowned with success.

2. *Redwater or Texas Fever.*

I may dismiss this disease in a few words. It is a most interesting disease and of great importance to stock farmers. It only affects cattle.

Geographical Distribution.—It is a disease found in almost every part of the world. It was first studied in North America; hence the name Texas fever. To Kilborne and Smith is due the honor of elu-

cidating the causation of this disease, and their work forms one of the most interesting chapters in the history of pathological science. They discovered that it was caused by the presence in the red blood corpuscles of a protozoal parasite closely related to the parasite found in east coast fever—the *Piroplasma parvum*. This organism is called *Piroplasma bigeminum*. They further discovered that this parasite was conveyed from sick to healthy cattle by means of a tick. They also showed that the cattle born and bred in certain southern districts are immune to the disease, whereas cattle in the northern districts are susceptible. Hence, if southern cattle were driven into the northern district, they gave rise to a fatal disease among the northern cattle; and, *vice versa*, if the susceptible northern cattle were driven into the southern district among the apparently healthy cattle of that district, they took Texas fever and died.

Texas fever was introduced about 1870, and is now endemic throughout most of South Africa. For many years the native cattle have been immune to the disease; that is to say, on account of being born and bred in a Texas fever locality they had inherited a degree of resistance to the disease which enabled them to pass through an attack when they were young, and so they became immune. But there is one peculiarity about Texas fever which does not occur in Rhodesian tick fever, and that is that the blood of an animal which has recovered from Texas fever remains infective—the germs remain latent—and so the native cattle of South Africa, although apparently healthy, are capable of infecting imported susceptible cattle with this very fatal malady. This is what makes it so difficult to import prize stock into this country.

When the Boers visited Mooi River, at the beginning of the war, they found a prize short-horn carefully stabled in Mr. P. D. Simmon's farm. They killed most of his stock for food, but left this short-horn bull alive. When they left the farm they turned this bull into the nearest field, in order, of course, that it might procure food. They had much better have eaten it. It promptly took Texas fever and died.

This disease, then, has become of secondary importance to South Africa in these days. The native cattle have become naturally immune, and the disease is only fatal to susceptible imported cattle. This, of course, discourages the importation of prize stock; but with the knowledge we possess it ought to be possible, by good stabling and prevention of contact with tick-infected cattle, to keep the prize stock alive for a reasonable time. The question of the feasibility of immunizing the prize stock while calves in England might be considered.

In regard to methods of conferring immunity on susceptible cattle many have been tried, but none are absolutely free from risk.

We may sum up in regard to redwater or Texas fever by saying that our knowledge of its causation and methods of prevention is much the same as it was ten years ago. The work done by Smith and Kilborne on this disease was of such a brilliant nature, and was done so thoroughly, that little has been left for later workers to do.

3. *Biliary Fever of Horses, Mules and Donkeys.*

This is a disease of horses, mules and donkeys very similar to redwater in cattle, and is caused by a closely allied parasite, the *Piroplasma equi*, discovered for the first time in South Africa by Bordet, Danysz and Theiler, and named by Laveran, of Paris.

It is similar to redwater, in that animals which have recovered from the disease re-

main a source of infection during the remainder of their lives to susceptible animals. The native South African horse is, like the cattle, immune to the disease. It is also conveyed by a tick, which has been shown by Theiler to be the 'red tick' (*Rhipicephalus evertsi*), the infection being taken in the nymphal and transferred in the adult stage. Theiler has also made the very important observation that if a horse is injected with blood from a donkey which has recovered from the disease, as a rule a mild form of the disease is produced, so that this opens up a method of immunizing susceptible horses which may probably prove of practical value. Theiler has also made another curious discovery. This disease of horses was found to greatly complicate certain immunizing experiments he was making against horse-sickness. He found he was introducing the *Piroplasma equi* at the same time he injected horse-sickness virus. But he found out that as the virus of horse-sickness keeps its virulence for years, whilst the *Piroplasma equi* dies out in a short time, this danger could be avoided by keeping the horse-sickness serum and virus for some time before using it.

4. *Malignant Jaundice of Dogs.*

This disease is most important to sportsmen or to importers of valuable dogs, as most of these are attacked sooner or later by this disease, and most of them succumb. It is also caused by a species of *Piroplasma* (*Piroplasma canis*), and is spread by the dog tick (*Hæmophysalis leachii*).

Like redwater and biliary fever, the blood of dogs which have recovered remains infective.

The story of the tick infection is a curious one, and the credit of its discovery is due to Lounsbury. It is only in the adult stage that the tick is capable of producing the disease. It is, therefore, evident that the *Piroplasma* must remain latent in the egg, the larval and nymphal stages, and only attain activity in the adult stage.

According to Theiler there exists a peculiar phenomenon which may be made use of to confer immunity. The blood of a dog which has recovered from this disease and has been hyper-immunized is, as mentioned above, capable of giving rise to the disease in a susceptible dog. Now, if serum be obtained from this blood and a quantity added to a small amount of the blood, this infected blood loses its infectivity and no disease results.

II. DISEASES CAUSED BY PARASITES BELONGING TO THE GENUS TRYPANOSOME.

1. *Nagana or Tsetse-fly Disease.*

We now come to the second group of diseases. These are also caused by blood parasites belonging to the same class of living things as the *Piroplasma,* but which are free organisms, swimming in the fluid part of the blood, and not contained in the red blood corpuscles, as are the others.

The first of this group I would draw your attention to is that disease called nagana or the tsetse-fly disease.

This fly renders thousands of square miles of Africa uninhabitable. No horses, cattle, nor dogs can venture, even for a day, into the so-called 'fly country.' Now what was our knowledge of this disease ten years ago? At that time it was thought that the tsetse-fly killed animals by injecting a poison into them, in the same way as a snake kills its prey. Nothing was known as to the nature of this poison in 1894. In 1895, on account of serious losses among the native cattle in Zululand from this plague, the then governor of Natal and Zululand, Sir Walter Hely-Hutchinson, started the investigation of this disease. The result of this investigation was the discovery that tsetse-fly disease was not caused by a simple poison elaborated by the fly, as formerly

believed, but that the cause of the disease was a minute blood parasite which gained entrance to the blood of the animals. This parasite is known by the name *Trypanosoma,* which signifies a screw-like body.

Ten years ago two species only had attracted much attention—one living in the blood of healthy rats, discovered by Surgeon-Major Lewis in India; and the other, a trypanosome, found in the blood of horses and mules suffering from a disease known in India as 'surra.' As the result of this investigation in Zululand, which lasted two years, it was proved that this trypanosome was undoubtedly the cause of the death of the horses and cattle struck by the fly, and that the tsetse-fly merely acted as a carrier of this blood parasite.

Here is a representation of the trypanosome of nagana on the screen. These trypanosomes consist of a single cell; are sinuous, worm-like creatures, provided with a macronucleus and micronucleus, a long terminal flagellum, and a narrow fin-like membrane continuous with the flagellum and running the whole length of the body. When alive they are extremely rapid in their movements, constantly dashing about, and lashing the red blood corpuscles into motion with their flagellum. They swim equally well with either extremity in front. These organisms multiply in the blood by simple longitudinal division, and often become so numerous as to number several millions in every drop of blood. They are sucked, along with the blood, into the stomach of the fly, live and multiply in the alimentary tract for several days, and, when the fly has its next feed on an animal, take the opportunity of gaining access to the blood of the new host, and so set up the disease.

Let me now throw on the screen a representation of the tsetse-fly (*Glossina morsitans*) which does all the mischief. Experiments were made which showed that the fly could convey the parasite from affected to healthy animals for at least forty-eight hours. It is a curious fact that among all the blood-sucking flies the tsetse fly alone has this power, and up to the present the cause of this has not been thoroughly cleared up. Lately, however, evidence has been brought forward to show that an enormous multiplication and development of the trypanosomes take place in the fly's intestine, a few trypanosomes multiplying to masses containing numberless parasites within twenty-four hours. Now, if this multiplication only takes place in the intestine of the tsetse-fly, and not in the other kinds of biting flies, this would probably account for the curious connection between the tsetse-fly and the disease. This multiplication of the trypanosomes in the tsetse-fly was discovered by Gray and Tulloch, two young army medical officers, while working in Uganda on 'sleeping sickness' during the present year.

Not only was it found that the tsetse-flies could convey the disease from sick to healthy animals, but it was also proved that the wild tsetse-flies brought from the 'fly country' and straightway placed on healthy animals also gave rise to the disease. The question then arose as to where the tsetse-flies living in the 'fly country' came by the trypanosomes. There were no sick horses or cattle in the 'fly country.' Investigation brought to light the curious fact that most of the wild animals—the buffalo, the koodoo, the wildebeeste—carried the trypanosomes in small numbers in their blood, and it was from them that the fly obtained the parasite. The wild animals act as a reservoir of the disease. The trypanosome seems to live in the blood of the wild animals without doing them any harm, just as the rat trypanosome lives in the blood of healthy rats; but when introduced into the

blood of such domestic animals as the horse, the dog or ox it gives rise to a rapidly fatal disease. The discovery that the wild animals act as a reservoir of the disease accounted for the curious fact that tsetse-fly disease disappears from a tract of country as soon as the wild animals are killed off or driven away.

In 1895 the living trypanosome which causes the tsetse-fly disease was sent to England in the blood of living dogs, in order that it might be studied in the English laboratories. These trypanosomes have been kept alive ever since by passage from animal to animal, and have been sent all over Europe and America, so that our knowledge of this kind of blood parasite has rapidly grown.

Koch, in a recent address, says that our knowledge of protozoal diseases is based on three great discoveries—that of the malarial parasite, by Laveran; of the *Piroplasma bigeminum,* the cause of Texas fever or redwater in cattle, by Smith; and, lastly, this discovery of a trypanosome in tsetse-fly disease.

We may, therefore, I think, congratulate ourselves on the growth of our knowledge of this great stock disease during the last ten years.

Since 1895 many other trypanosome diseases have been discovered in all parts of the world. The latest and most important of these is one which affects human beings, and is known as 'sleeping sickness.' This 'sleeping sickness,' which occurs on the West Coast of Africa, particularly in the basin of the Congo, has within the last few years spread eastward into Uganda, has already swept off some hundreds of thousands of victims, is spreading down the Nile, has spread all round the shores of Lake Victoria, and is still spreading southward round Lakes Albert and Albert Edward. This disease is in all respects similar to the nagana or tsetse-fly disease of South Africa, except that it is caused by another species of trypanosome and carried from the sick to the healthy by means of another species of tsetse-fly, viz., the *Glossina palpalis.*

I now throw on the screen a map of Africa, showing, as far as is known up to the present, the various fly districts, and you will see from this map that it is not at all improbable that this human tsetse-fly disease may spread southward through the various fly districts to the Zambesi, and may even penetrate as far as the fly districts of the Transvaal and Zululand.

I am sorry to say that, in spite of innumerable experiments directed towards the discovery of some method of vaccination or inoculation against these trypanosome diseases, nothing definite, up to the present time, has been discovered. At present there does not seem to be any likelihood that a serum can be prepared which will render animals immune to the tsetse-fly disease. In the same way it has also been found impossible, up to the present, to so modify the virulence of the trypanosome as to give rise to a modified, non-fatal form of the disease. Again, all attempts at discovering a medicine or drug which will have the power of killing off the parasites within the animal organism, without at the same time killing the animal itself, have not as yet been successful, although some drugs, such as arsenic and certain aniline dyes (Ehrlich), have a very marked effect in prolonging the life of the animal. As this disease is fatal to almost every domestic animal it attacks, it seems very improbable that there is much chance of cultivating an immune race of horses, dogs or cattle which will be able to withstand the action of the parasite. It is quite evident that if an acquired immunity of this kind could be brought about, such a race of immune animals would now be found; but, as a matter

of fact, there are no horses, dogs or cattle in the 'fly country.' In other protozoal diseases, such as the *Piroplasmata*, this acquired immunity seems to come about fairly readily.

To sum up, then, the increase in our knowledge of tsetse-fly disease during the last ten years, we may say that we have discovered the cause in the shape of the small blood parasite *Trypanosoma;* we have found that the reservoir of the disease exists in the wild animals, and that we can blot out this disease from any particular tract of country by the simple expedient of destroying or driving away the wild animals. We still have no means of preventive inoculation or successful medicinal treatment in this disease.

2. *Trypanosomiasis of Cattle.*

This disease seems to be widespread over all South Africa. It can not be said to be of much practical importance, as the cattle infected do not seem to be seriously affected by it. It is caused by a species of trypanosome remarkable for its large size, which was discovered by Dr. Theiler some years ago, and named *T. theileri.*

Dr. Theiler states that it is conveyed from animal to animal by the common horse-fly, *Hippabosca rufipes.*

This, then, is a short account of the trypanosome diseases which affect South Africa.

Of late years the tsetse-fly disease has become of less practical importance to the Transvaal, from which it has practically disappeared. This is due to the disappearance of the game, killed off by rinderpest; but with the preservation and restoration of the reserves with big game the disease is certain to reappear. Why the fly should disappear with the game is not known.

D. BRUCE.

(*To be continued.*)

EUROPEAN AND AMERICAN SCIENCE.

ONE of the important accomplishments, doubtless, of the International Congress of Arts and Science held in connection with the exposition at St. Louis was, simply, the bringing to this country of a large number of learned men from other nations. Some of these men had visited America before, but many of them crossed the Atlantic last autumn for the first time and viewed Americans and American institutions with, as it were, a virgin sense. A number of those who made the trip have recorded their impressions in addresses or journal-articles. It would be a worthy task, should these increase in number, to collect and to publish them together, for aside from the gratification of the curiosity of seeing ourselves as others see us, it could scarcely fail to be instructive for us to study the observations and comments of men of the high type of those who were invited to the congress.

Of the foreign scientists who attended the St. Louis meeting and have given public expression to their ideas of America, one of the most distinguished and discerning is the professor of anatomy in the University of Berlin. It was not Professor Waldeyer's first visit to America; fond of travel and widely-travelled as he is, it was not for a man such as he to have left so long America unvisited. Moreover, an omnivorous reader, Waldeyer is more or less familiar with American literature; he numbers, too, among his friends many American scientists and literary men; indeed, many young biologists and anatomists from America have, in part at least, received their training in his laboratory. By personal observation, by correspondence, by reading and by multiple contact with educated Americans, Professor Waldeyer has had, more than most foreigners, opportunities for familiarizing himself with American science and American thought.

It must, therefore, be of especial interest to people in this country to know that he has recently referred at some length to the subject of the relation of Europe (and especially Germany) to American science, and to learn, in brief at least, what are his views concerning it.

Waldeyer discussed the matter in a *Festrede* delivered at an open session of the Royal Prussian Academy of Sciences in Berlin early this year.[1] The occasion was the double celebration of the Kaiser's birthday and the anniversary of King Frederick II. The first part of the address dealt with the political relations of Germany and America, with especial reference to Frederick's attitude toward the American republic at its birth, a natural topic in view of the recent presentation of the statue of Frederick the Great to the American nation. It is the second part of the address which is of chief interest to the readers of SCIENCE, as it considers the special matter of the relation of Europe and of Germany to science in America. The whole address is characterized by a wish for harmonic relations, by a keen desire to foster and favor international scientific intercourse and by a plea for the avoidance of everything in the way of mutual misunderstanding and unseemly discord. It is a liberal and broad-minded statement, certainly as fully lenient to America as one could ask; it can scarcely fail to cement good feeling and to promote intercontinental harmony among scientific men. On adverting to this special topic Waldeyer points out that if two peoples are to cooperate in the work of the advancement of culture, the first necessity is mutual respect between them. Each must have something good, something self-achieved to offer, each must preserve its own individuality, not with obtrusive ostentation, but quietly and with that certainty which naturally accompanies the feeling of health and strength; for nations are like men—he who has not confidence in himself will also soon be given up by others. He urges the necessity of stilling those tendencies which arise from time to time in one nation to unjustly threaten or injure another, the desirability of getting rid of prejudices and of clearing up misunderstandings and unjust suspicions of the other, the importance of directing attention in each nation to the good in the other, of which it is often ignorant, owing to lack of knowledge of the nature of the people and of their civic and social institutions. This, he points out, is why Germans, in order to maintain a healthy and useful relation to American science, must, above all, know how the American thinks about culture and science, what the present position of science and scientific investigation in America really is, and how it is likely to shape itself in the near future.

Waldeyer admits that in Germany the false opinion that the American turns predominantly toward material interests and that he has but little inclination for purely scientific things is still widespread. Those who hold it, he says, forget America's great universities—Harvard, nearly 300 years old, with its 5,000 students per year; Yale, more than 200 years old; Princeton; Brown; the University of Pennsylvania, contemporaneous in foundation with Göttingen; Columbia, established seven decades ago; and young institutions, like Johns Hopkins, Cornell, the University of Chicago and the University of California, already grown to powerful positions in the country. If Germany bore in mind the great public libraries which exist in America, with their magnificent equipment, their easy access and their prodigious use by all classes, in-

[1] Waldeyer, W., 'Festrede,' *Sitzber. d. kg. Preuss. Akad. d. Wissensch.*, 1905, IV., 105–121.

cluding the working people, such a wrong impression could not prevail. The American's recognition of the fact that culture brings freedom with it, and his realization that, in a country where every one has the choice of sinking or swimming, a good education is a necessity for him who will hold himself above water in the fierce struggle, have led to the expenditure of great sums for public schools, for advanced education of all sorts, for museums, collections, laboratories, and the like, with results as good or better than those attained in Germany. Waldeyer, impressed with American progress in this regard formerly, confesses himself surprised at the advances made in the last decade. They surpass, he says, all expectations. "One needs no special prophetic gift to predict that, in fifty years, the United States will, as regards good arrangement, ease of use and wealth of what is offered, far outdo Germany."

Before attempting to answer the question, 'With all this liberal provision in the way of making arrangements for scientific work, has anything already been achieved in America?' Waldeyer turns to an intermediate consideration, to a general discussion, namely, of the factors which permit and foster the development of unusual men. The relative potency of heredity and environment is considered. The basis for any special capacity, be it bodily or mental, is an inborn gift of nature; it can not be increased in a given organization beyond the limits permitted by that organization. A mathematician can not be made of a man whose brain has not the necessary endowment therefore, any more than a singer can be developed if the individual be too defective in temporal lobe, ear or larynx. Here and there such natural capacities appear hereditarily in families, but as often or oftener the reverse appears to be the case. And it is not wealth or social position which produces these extraordinary capacities; on the contrary, capable heads of the first rank emerge just as often from among the masses; they come from those in poor circumstances as frequently as from families that have long enjoyed conditions of preferment—an illustration of the beneficent and compensative justice of nature! That certain races are preferred can not be denied—the history of science teaches it. They are those races whose individuals, along with a healthy and harmonic development of the body as a whole, possess the largest brains relative to the body-mass. Climate, using the word in its broadest sense, here, doubtless, plays a part. Neither the prevailing darkness of the poles nor the flood of sunlight at the equator is suitable; it is a temperate climate in countries manifoldly broken up into land and water, where the soil is fertile, and the whole gamut of seasons is run through, which must be designated as most favorable. In such a climate men must work, but the work rewards and strengthens. Not that this climatic factor works directly; rather its action is such that it gives rise to strong, healthy men with superior brains. On the other hand, it is just as true that culture already attained and institutions of favorable influence already established, such as superior schools, well-organized and liberally endowed libraries and provision for the interchange of mental products, often help to permit intellectually important men to appear. As of two equally well-organized muscles, that becomes more efficient which is given the opportunity to exercise and test itself; so of two equivalent brains, the one which is offered the more abundant and better intellectual nourishment and the greater opportunity for exercise will yield the higher product. Many a highly endowed head has failed to become fully active, owing to

the existence of barriers to its development. Great geniuses like Napoleon I., Shakespeare and Gauss may, it is true, overcome every obstacle; by virtue of their extraordinary creative power they can do without and still not be held back; but easily accessible aids will undoubtedly awaken to able performances men of capacity, who otherwise would slumber.

On comparing 'old Europe' with the United States Waldeyer points out that the 'climatic' factor is in both instances all that can be desired. Though in western North America there are wide areas less favorably situated, a vast proportion of the country is as favorably located and formed as any part of Europe. The type of man is the same, indeed the whole of Europe has sent, in large part, of its best to contribute to the population of the United States. The means of culture are the same; in many respects America has the advantage, especially as regards ease of use and multiplicity of institutions. There can be no doubt, then, that in America effective men and women must develop in all spheres. Waldeyer calls the attention of his countrymen to the fact that it is by no means, as some think, in the natural sciences and technical subjects that Americans have already distinguished themselves; he cites, in evidence, a list of naturalists, economists, jurists, philologists, philosophers and historians of the first rank.

Some of the reasons for German failure to comprehend Americans are made clear. To understand the people of the United States properly, one must, he emphasizes, keep in view the fact that even their oldest towns never had walls, that there have never been feuds between cities, nor struggles between lords and men, that compulsory service and burdens other than those self-imposed are unheard of, and that the state does not trouble itself about religious creeds, nor these about the state. All this affords a wide horizon and creates a feeling of personal independence—a feeling which Americans inherit from the founders of the republic and which is traditionally maintained in their bringing-up.

The magnificent equipment of America's scientific institutions reflects the national character. High praise is accorded by Waldeyer to the Smithsonian Institution, from which so many foreigners have received favors; to the Washington Academy of Sciences, with its various subdivisions; to the American Association for the Advancement of Science, and to the National Educational Association. But as a biologist, the Berlin anatomist is best able to judge of the state of the biological sciences here. After referring to his personally repeated conviction of the advances making in America he says: "I find that over there they stand equal to us in all essential points, in the kind and method of scientific work, in the value of the same, in the equipment and arrangement of laboratories, in materials for instruction and in the form and mode of imparting knowledge. Visit the great workshop of Alexander Agassiz in Cambridge; the anatomical institutes of Huntington in New York, at Columbia University, and of Mall in Baltimore; the Peabody Museum, so brilliantly filled by Marsh, at Yale; the anthropological museum in New York, etc., and you will say that I am right. J. Orth has recently made a similar statement. In a few years the new buildings of the Medical School at Harvard will be ready; * * * it may be prophesied that in them we shall have the best to be seen anywhere."

In view of the present standing and promise for the future of science in America, Waldeyer, proceeding with his address, urges the maintenance and strengthening

of the ties which now knit together the scientific interests of Europe and America. A comparison of the scientific 'capital' of the two countries, the climatic prerequisites and the creative and thinking human material, reveals an equivalence. If Europe is still ahead in antiquity of culture material and historical substrata, it will not be so long before America catches up. While European scientific institutions are good, care must be taken lest the freedom of their management be restricted, and Waldeyer warns his colleagues that otherwise Europe will soon fall behind America, for science and art flourish only in the open air!

In one large feature Europe is still, Waldeyer declares, ahead of America, and that is in the making of great scientific discoveries and the formation of those theories which have opened up wholly new domains of knowledge. To Europe, he says, belongs the credit of a surprisingly large number of new chemical elements, spectral analysis and, with it, astrophysics, the great discoveries in the chemistry of dyes and sugars, the physical chemistry of solutions, the liquefaction and condensation of gases, especially liquid air, the Röntgen and Becquerel rays, radium and its rays, color-photography, the dynamo-machine, electric light, indeed, most, he asserts, of the investigations and applications of electricity as a source of power, the electric furnace and its fruitful application; in the field of biology almost the whole doctrines of the protozoa and bacteria with their explanations of epidemics, the toxines and antitoxines, the working-out of the doctrine of immunity, the discovery of the finer processes of fertilization and of karyokinesis, the doctrine of descent and Darwinism, and above all, crowning all, the conception and foundation of the great idea of the conservation of energy. These he lists as the discoveries and theories of European investigators during the past fifty years; many of them belong to the immediate past. It would be possible to enumerate a series of men and researches in the domain of the historical and philosophical sciences also, which would easily demonstrate that, in them, too, the main weight of achievement still rests in Europe. He rejoices that Europe, with Germany in the heart of it, has retained up to the present its freshness in intellectual work and its youthful vigor. As long as the climatic factors remain as favorable as they now are there will be no lack of intellectual accomplishment.

Particularly noteworthy is a comment made by Waldeyer on the importance of the retention of individual character in men and institutions. The schooling of German youth has, he thinks, hitherto been good, and he values highly the independence of the German university. Too great a similarity should, he urges, be opposed. The strength of an investigator, of a scholar or of a teacher lies in the development of his peculiar powers. In Germany individuality in investigating and teaching is usually well marked; this, he lays stress on, should be left undisturbed, and, all the more, because in America there is a marked tendency toward making things uniform (*um so mehr, als in der Union alles zu einer gewissen Uniformirung drängt*).

While western Europe still occupies the first place in the field of science, the lecturer warns European workers that they dare not rock themselves to sleep in the pleasant certainty that this will continue to be true. "America's scientific capital is equal to ours; she is well in the way toward preceding us in the culture of the sciences. She has already produced men and performances of the first rank in considerable numbers; over night there may

be more of them. Above all, then, let us seek to keep company with America in the nurture of science. Let us unhesitatingly allow to the Americans what they have which is as good or better than ours; let us receive it from them gladly. And if we, through unceasing vigorous performance, can preserve for ourselves their respect and their attention, we shall, in the field of the sciences, help to knit closer the natural bond which exists between Germany and America."

Young Americans have, up to now, gone to Germany to learn from her teachers, but the time has arrived, Waldeyer continues, when German and European students should also go to America to widen their culture. This scientific intercourse between person and person, university and university, academy and academy should be favored in every way possible. "Let us be as liberal to them as they are toward us in the reception of those who seek knowledge, in offering to them all that they need. Let their published researches be found in our libraries also, at least in the great Royal Library of the capital of the empire. Let us show them in all things that on coming to Germany they come to a people of intellectual affinity, under whose political and social institutions even they, with their free views, may have a feeling of well-being. That they do the same for us can be said, to their praise, by all who have been their guests."

Germans should act toward America, he believes, as Americans do toward Germany; they should try to form a correct judgment of the scientific work of Americans by personal knowledge; more than hitherto, Germans must instruct themselves by visiting the country itself. It would do no harm if every year a number of German students went to America to widen their horizon. The plan of exchanging university professors, already introduced, is highly commendable and should be further realized. While he does not feel called upon to give advice to Americans as to their future relations to Germany, Waldeyer says that he knows that, if Germans can remain at the high scientific level they have hitherto occupied, Americans will need no advice; they will gladly maintain their old relations as regards science, and will extend them. "And thus, aside from all else, looking purely at science and its service, will not, in such intercourse, the noblest and highest mission be fulfilled: the advancement and elevation of culture from people to people?"

It is difficult in an abstract to do anything like justice to such an address. All who are familiar with the beauty of Waldeyer's literary expression will desire to read the report in the original.

LEWELLYS F. BARKER.

SCIENTIFIC BOOKS.

A Select Bibliography of Chemistry 1492–1902. By HENRY CARRINGTON BOLTON. Second Supplement. City of Washington, published by the Smithsonian Institution. (Smithsonian Miscellaneous Collections, Part of Vol. XLIV.) 462 pp.

The first volume of Dr. Bolton's 'Select Bibliography of Chemistry' brought the literature down to 1892. The first supplement continued the work down to the close of 1897. In 1901, Section VIII., 'Academic Dissertations,' was published separately. The present work continues the whole work down to the close of 1902, and adds many titles, especially of academic dissertations, which had been overlooked in the earlier volumes. The following table will give an idea of the space occupied by the different portions of the book: Section I., 'Bibliography,' 5 pages; Section II., 'Dictionaries and Tables,' 6 pages; Section III., 'History of Chemistry,' 11 pages; Section IV., 'Biography,' 15 pages; Section V., 'Chemistry, Pure and Applied,' 162 pages; Section VI., 'Alchemical Literature of the

Nineteenth Century,' 19 pages; Section VII., 'Periodicals,' 11 pages; Section VIII., 'Academic Dissertations,' 167 pages; subject-index, 66 pages.

Doctor Bolton died on November 19, 1903, while the book was passing through the press and most of the proofreading, as well as the preparation of the index, was done by Mr. Axel Moth, of the New York Public Library. This work has been done with a care and excellence that could hardly have been surpassed by Dr. Bolton himself.

Reference has been made in a previous review to the great value of the list of academic dissertations, and increased value is added by the continuation of the list through 1902 in the present supplement. It is to be hoped that at least this portion of the work will from time to time be brought down to date.

In this connection it is interesting to note not only the great amount of this literature but also the sources from which it emanates. The list includes for the five years, 1898–1902, about 2,350 dissertations, or nearly 500 a year. As we should expect, the dissertations from the University of Berlin head the list, about ten per cent. emanating from this source. It is, however, a surprise to find that the rather unfamiliar University of Rostock comes next with only a dozen less dissertations to its credit. Heidelberg stands a little lower in numbers. Next come Munich, Erlangen and Freiburg in Baden, with about 160 each, and then Leipzig, which we should expect to find relatively much higher in the list, with 130. Basel and Marburg are the only other universities which reach 100. Zürich furnishes about 70 dissertations and then come Bern, Breslau, Freiburg in Switzerland, Geneva, Giessen, Göttingen, Halle, Kiel, Tubingen and Würzburg, each with about 50. This list probably furnishes a pretty good index of the quantity of chemical work done at the different universities, but it must not be overlooked that it is a common practise for students to go for their diplomas to a university where the requirements are known to be less rigid than at Berlin or Leipzig.

The loss of Dr. Bolton to the chemical world is great. Aside from his other work in chemistry, in two fields he was almost unique. As an antiquarian he was always bringing up interesting and valuable information from his rich mine of historical knowledge of the early days of chemistry and alchemy. But, perhaps, it is as a bibliographer of chemistry he will be best remembered. His 'Select Bibliography of Chemistry' might almost be considered a monumental work, so great is its scope and so thoroughly is it carried out. While it has the title of 'select' rather than 'complete,' it is remarkable how little material of value is omitted. It is safe to say that his work is final as far as it goes. His bibliographical work is not limited to that which he personally carried out, for he inspired others in the same field. To his influence we owe most of the bibliographies of special elements and allied subjects, which have been published by the Smithsonian Institution, on the recommendation of Dr. Bolton, as the chairman of the American Association committee on indexing chemical literature.

Now that the 'International Catalogue of Scientific Literature' is under way, a part of the work for which Dr. Bolton was so solicitous has become an accomplished fact. The Smithsonian Institution has for the present ceased publishing special bibliographies of chemical subjects, and in view of the immense mass of nineteenth century scientific literature which ought to be indexed and the need of its systematic treatment, this is undoubtedly wise. Under the circumstances it is doubtful if there is longer reason for the continuance of the association committee, of which Dr. Bolton was from the first chairman and moving spirit. In the field of chemical bibliography, he will have no successor.

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SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Experimental Zoology, Vol. II., No. 3 (August, 1905), contains the following papers: 'A Study of the Germ Cells of Aphis rosæ and Aphis œnotheræ,' by N. M. Stevens. Only one polar body is formed, and there is no reduction in the number of chro-

mosomes in either the male or the female parthenogenetic generations. Reduction in the sexual germ cells is effected by longitudinal pairing of like chromosomes. The behavior of the chromosomes in *Aphis* exactly fulfils the conditions required by Mendel's law of heredity; and their form and size relations offer support to the theory of the 'individuality of the chromosomes.' The results also suggest that sex may be determined in *Aphis* by a change in dominance of the sex-character, brought about by external conditions. 'Regeneration in *Polychœrus caudatus*,' by N. M. Stevens and A. M. Boring. So far as regeneration in *Polychœrus* has been tested by the authors it seems to be largely a question of 'organization' and 'totipotence' of material, modified in many cases by the folding under and uniting of the anterior cut surfaces. Histological examination of the regenerated parts shows the process to be one of pure morphallaxis. 'The Relation of the Degree of Injury to the Rate of Regeneration,' by Charles Zeleny. The rate of regeneration of a removed chela of the cray-fish is greater when other appendages are removed at the same time than when it alone is removed. A similar result was obtained with other forms, disproving the common belief that an increase in the degree of injury to an animal lowers its vitality and thereby diminishes its capacity for repairing sustained injuries. 'Studies on Chromosomes: 1. The Behavior of the Idiochromosomes in Hemiptera,' by Edmund B. Wilson. The author gives an account of the distribution of the chromosomes to the spermatozoa in several species of Hemiptera, and shows that two classes of spermatozoa are formed, in equal numbers, which differ only in respect to the size of one of the chromosomes (called the 'idiochromosome'). A discussion is given of the bearing of the facts on Mendelian inheritance, sex-determination, and the origin and meaning of the accessory chromosomes. 'The Movements of the Swimming Plates in Ctenophores, with Reference to the Theories of Ciliary Metachronism,' by G. H. Parker. Experiments were made upon *Mnemiopsis* and *Pleurobrachia* and the conclusion reached that transmission of the impulse to ciliary movement is neuroid in character, though this is probably supplemented by mechanical transmission. 'On a General Theory of Adaptation and Selection,' by Henry Edward Crampton. The 'Principle of the Correlative Basis for Selection' is developed upon the results of the author's statistical and experimental studies upon saturnid lepidoptera. The principle states that selection proceeds with reference to the condition of correlation of the organism, and that this condition involves the whole series of external influences as well as all the internal 'characters' of individuals. 'Experimental Studies on the Development of the Eye in Amphibia: II., On the Cornea,' by Warren Harmon Lewis. The cornea will not form without the optic cup or lens coming into contact with the ectoderm, and the influence of these organs can cause corneal formation in ectoderm which under normal conditions never gives rise to a cornea. The cornea is neither predetermined nor self-differentiating.

The July–August number of the *Journal of Geology* contains an article by Professor W. M. Davis, entitled 'The Geographical Cycle in an Arid Climate,' which he considers under the subheadings of 'initial, youthful and mature stages' and 'the beginning of old age.' Professor Davis concludes that 'the scheme of the arid cycle thus seems to be as well supported by appropriate facts as is the scheme of the normal cycle.' Mr. E. S. Bastin furnishes a 'Note on Baked Clays and Natural Slags in Eastern Wyoming.' Professor Charles S. Prosser contributes an article on 'The Delaware Limestone' which is the upper formation of the Devonian limestones of Ohio, while the lower one is known as the Columbus limestone. It is shown that the limestone in the northern part of the state, which Newberry named the Sandusky and supposed to be the upper formation, really represents the Columbus and, therefore, the formation name Sandusky is dropped and Orton's later one—Delaware limestone—adopted. Mr. Richard S. Lull has a paleontological paper, entitled '*Megacerops Tyleri*, a new species of Titanothere from the Bad Lands of South Dakota,' illustrated by

two plates. The number concludes with a "Comment on the 'Report of the Special Committee on the Lake Superior Region'" by Dr. Alfred C. Lane, stating why he "was willing to accept 'Laurentian' as a term apparently stratigraphic and coordinate with stratigraphic terms."

THE July number of the *American Geologist* contains a biographical sketch with portrait of the late 'Clarence Luther Herrick,' by Professor W. G. Tight. Dr. Ida H. Ogilvie contributes an article on 'The High Altitude Conoplain; a Topographic Form Illustrated in the Ortiz Mountains' of New Mexico. The conoplain is named and described as the plain sloping away from the Ortiz laccolith on all sides which has been partly built and partly cut. Professor W. O. Crosby publishes the first installment of an article on the 'Genetic and Structural Relations of the Igneous Rocks of the Lower Neponset Valley, Massachusetts,' which is stated to be an advance presentation, in outline, of a portion of 'the author's detailed and systematic study of the Geology of the Boston Basin.'

WE have received notice that in October next will be issued the first number of *The Journal of Biological Chemistry,* designed for the publication of original investigations of a chemical nature in the biological sciences, whether concerned with the phenomena of animal or of vegetable life. Without rigidly defining the scope of the *Journal,* it may be stated that its pages will be open (1) to workers in zoology and botany and the branches of knowledge in which these sciences are applied, for such of their researches as are of a chemical or physico-chemical nature; (2) to workers on the chemical side of the experimental medicinal sciences, as physiology, pathology, pharmacology, hygiene, physiological chemistry and bacteriology; (3) to those who are engaged in any branch of clinical medicine, when their researches are of a chemical nature; (4) to the specialist in organic chemistry, who will find here a fitting place for the publication of researches which have biological or medical interest. Contributors will be allowed prior publication of announcements or abstracts in other journals. Every legitimate effort will be made to bring the *Journal* to the notice of foreign readers and workers. At least six numbers will be issued yearly and will constitute a volume, each volume to contain between five and six hundred pages. The responsible editors will be John J. Abel, Baltimore, and C. A. Herter, New York. With them will cooperate as associate editors R. H. Chittenden, New Haven, Conn.; Otto Folin, Waverly Mass.; William J. Gies, New York; Reid Hunt, Washington, D. C.; Walter Jones, Baltimore, Md.; Waldemar Koch, Columbia, Mo.; J. H. Kastle, Lexington, Ky.; Graham Lusk, New York; Jacques Loeb, Berkeley, Cal.; P. A. Levene, New York; A. B. Macallum, Toronto, Canada; J. J. R. McLeod, Cleveland, O.; L. B. Mendel, New Haven, Conn.; F. G. Novy, Ann Arbor, Mich.; W. R. Orndorff, Ithaca, N. Y.; Thomas B. Osborne, New Haven Conn.; Franz Pfaff, Boston, Mass.; A. E. Taylor, Berkeley, Cal.; V. C. Vaughan, Ann Arbor, Mich.; Alfred J. Wakeman, New York; Henry L. Wheeler, New Haven, Conn.

DISCUSSION AND CORRESPONDENCE.

THE MUTATION THEORY.

THE paper by Professor White, beginning on page 105 of this volume, although, it seems to me, somewhat obscure in diction at times, as for instance near the bottom of the first column on page 109, where the expression 'rare genera' probably means isolated genera, is nevertheless most interesting and opens up many lines of thought and contemplation. There seems to be but little doubt that the main argument is wholly correct. The facts have of course long been known, and, in the Darwinian hypothesis relating to the origin of species by gradual evolution, an attempt is made to explain them by lost records or long time intervals of upheaval and denudation, the changes in species being gradually brought about in the meantime in some other region or environment. This assumption will not satisfy the long array of observed facts, however, especially in the case of land animals, and we are forced to adopt some such theory as that of

abrupt mutations in order to account for them. We are familiar with multitudes of cases where genera, orders or even classes seem to appear suddenly, but, as far as known to the writer, not a single instance where any considerable number of the minute morphological variations called for by the Darwinian theory in leading up to the new types, can be satisfactorily traced. It would appear, if the Darwinian theory were correct, that at least a few of the radical replacements by altered forms of life might be traceable by actual fossil remains in the underlying rocks.

The subject was very strikingly brought to my attention some time ago in studying the extensive family Pleurotomidæ of the gastropod Mollusca,—an important group, containing many genera and a vast array of species, which seems to come abruptly into being at the beginning of the Tertiary period. Some species supposed to belong to the family have been described from the upper horizons of the Cretaceous, but these are not sufficiently numerous or transitional in nature to affect the general truth of the above statement. Some of the better defined genera, such as *Gemmula,* appear abruptly in the earliest Eocene, in forms fully as well developed as those now living, and, in fact, some early Eocene species so closely resemble living shells that it is scarcely possible to distinguish them. There is not a particle of generic change, even in the complex embryo, from the time of their sudden appearance at the opening of the Eocene to the present time. Many genera, however, endure only until the end of the Eocene-Oligocene period, when there occurs again a rather universal and abrupt change of generic types.

At Vicksburg, Miss., appears a formation generally assigned to the Lower Oligocene, which may be resolved into two principal horizons, the lower of which is composed of fine light gray fossiliferous sand, with but little admixture of clay and alternating in thin strata with subequal thicknesses of more or less friable limestone, the upper consisting of an equally fossiliferous ferruginous red marl. In some places these two horizons are separated by a bed of blackish-gray compact clay, full of fossils which so closely resemble those of the upper marl that there can be but little question of its properly forming part of the upper horizon. These two horizons were probably separated by a time interval not very great, geologically speaking, possibly not more than a few thousand years—a relatively short time in the life history of most species,—during which the lower beds may have appeared above the ocean and have been subject to denudation until they were again submerged to receive the upper marls, the local conditions having changed somewhat in the interval, as shown by the different constitution of the beds as related above. In regard to the Mollusca of the two horizons, I find after a rather thorough exploration of both, extending over several years, that there is unexpectedly little in common between them. Probably not more than 40 per cent. of the species of either horizon are common to the two, and, in several instances, even these are at least varietally modified. There are, of course, a number of species of the lower beds represented by evident descendants in the upper marls, but what it is desired to lay particular stress upon in this connection, there are many widely divergent or wholly unrelated types appearing in the latter that are not even suggested in the former. Perhaps the exploration is not as yet sufficiently extended, but this is at least the present status of knowledge, with an equally thorough investigation of the two horizons as they are now exposed in the bluff at Vicksburg.

The mutation theory is evidently the best that has been advanced to account for these known facts. It should be especially acceptable to the theologians, also, as they maintain the spiritual and undying nature of man. If we conceive that man originated abruptly by some unaccountable molecular change in the ovum producing the original twins, Adam and Eve, there can be no doubt of the time when man became thus immortal, whereas there would be necessarily much uncertainty as to the time when this occurred among the successive infinitesimal increments of brain development necessitated by the Darwinian theory.

Born thus in the womb of the lower ani-

mals, man has become the most wonderful living thing on earth, separated by a great gulf from his next of kin, and yet, in spite of his high degree, afflicted with more diseases than any other animal and beset by at least as many tormenting parasites. Inexperienced in his early history, his mind steadily advanced until to-day he contemplates all nature with a yearning to know its mysteries. The changes in the germ-cell sufficing to evolve him are as inscrutable to his reason as the constitution of matter and the interstellar ether, the nature and origin of the cosmical forces and of chemical affinity, the conditions obtaining on other worlds revolving about untold millions of other suns, or the origin, nature and meaning of life itself. But we ardently desire to know these things, to peer out into unfathomable space and to speculate upon the meaning of our existence and the unknowable as we perceive it all about us in the universe. Under such circumstances are we to live but a short time on earth and then be consigned to everlasting oblivion? In contemplating the real significance of the word eternal or everlasting, which must refer to infinity—a duration of time so inconceivable that a number of years expressed in pica type encircling the entire globe would be as naught when compared with it—our reason would appear to answer in the affirmative. But, as a species—*sapiens*—of the genus *Homo*, we can never know. We seem to be but intellectual atoms floating in an infinity of space and time.

THOS. L. CASEY.

ST. LOUIS,
August 3, 1905.

SPECIAL ARTICLES.

THE SPEARMAN CORRELATION FORMULA.

SOME time ago C. Spearman published a formula for calculating the true correlation by the Pearson formula for observations in themselves variable.[1] This method has been used by several psychologists without a full understanding of the way in which Spearman arrived at the method. Such a use of the method is dangerous since those who apply it can not be accurately informed as to the conditions under which it holds.

Let

T represent the type.

σ represent the variability of the group.

t represent single observations upon individuals.

N the norm of the individual.

v represent the variability of the individual with respect to his norm, including the error of observation.

Assuming that all t's follow the exponential law and representing averages by [ ], we shall find in the long run that

$$[t] = [N] = T.$$

The observed variability of the group may be expressed as

$$\sqrt{\sigma^2 + v^2}$$

in which σ represents the true variability that determines the true correlation in the Pearson formula. The whole problem in practise is to find the value of v.

Spearman says that the true correlation may be obtained by dividing the average correlation for the various trials of the two tests by the square root of the product of the correlations for the successive trials for each test.

Let,

xy = the average product of the deviations for the corresponding single trials in two tests.

$(pq)_1$ = the same for t_1 and t_2 of the first test.

$(pq)_2$ = the same for t_1 and t_2 of the second test.

v_1 and v_2 = the true variabilities of individuals in the two tests.

σ_1 and σ_2 = the true variabilities as calculated for x and y.

Then by substitution in the formula of Spearman,

$$r^2 = \frac{\dfrac{[xy]^2}{(\sigma_1^2 + v_1^2)(\sigma_2^2 + v_2^2)}}{\dfrac{(pq)_1\,(pq)_2}{(\sigma_1^2 + v_1^2)(\sigma_2^2 + v_2^2)}}$$

$$r^2 = \frac{[xy]^2}{(pq)_1\,(pq)_2}$$

Hence,

$$\sigma_1^2\sigma_2^2 = (pq)_1\,(pq)_2$$

$$\sigma_1^2 = (pq)_1$$

[1] C. Spearman, *American Journal of Psychology*, January, 1904.

Thus the formula assumes that the successive observations upon the same individual, or t_1 and t_2, are constituents of the same norm in conformity to the exponential law. The method is simply a way of eliminating v from the expression. The assumption upon which the whole rests is that $[pq]$ will be constant no matter what the magnitude of v.

Now, in tests as taken in psychological laboratories it is evident that some change in the norm results with each successive trial. In all tests we find practise, warming-up, etc., as factors leading us to consider the successive t's as ordinates of a curve whose abscissa represents units of time. In practise, at least, we assume a type of curve toward which all individuals tend. The individual curves are variants in the group defined by the type curve. The same conditions are found in growth of stature. It has been shown that individuals tend to the same curve of growth. Also that when an individual varies greatly from the type curve at one period of time he is likely to vary less at another.[2] This implies that the individual tends to fill a space type in a time type so far as his physical growth is concerned. If this is true we should expect to find the same relations with respect to the form of any organ.

I have at hand data for measurements of the alveolar arch with reference to the median plane of the body. These measurements were taken as ordinates of the curve as defined by the teeth. This gives us the same general geometric conditions as were found in curves of growth. Now, before going on with the data let us consider the problem as that of a correlation between the ordinates of individual curves, varying from the type curve according to the exponential law.

We may assume that OM represents any curve. Let t_1 be the first observed trial or ordinate; t_2, the second. Now, no matter what the value of t_2 may be, there must be a correlation between t_1 and t_2 because of their geometric relations. Also, there may be a relation between $(t_1 - t_2)$ and t_2.

Let

[2] Franz Boas, Report of the Commissioner of Education for 1896–7.

$[t_1] - [t_2] = [P]$,

σ_1, σ_2, σ_3, the respective variabilities of these averages,

$x =$ the deviations of t_2 from $[t_2]$,

$y =$ the deviations of t_1 from $[t_1]$,

$y = x + p$.

Then $(x + p)$ is a variable agreeing with a variable y; p is the deviation of $[P]$.

$$[xy] = [x^2] + [xp],$$

$$[y^2] = [x^2] + 2[xp] + [p^2].$$

Also

$$[y^2] = \sigma_1^2,$$

$$\sigma_1^2 = \sigma_2^2 + \sigma_3^2,$$

$$[y^2] = [x^2] + [p^2].$$

Hence, $[xp]$ should be zero, but this can occur only when there is no correlation between t_2 and P.

The value of p may be expressed as

$$[p^2] = [y^2] - 2[xy] + [x^2].$$

Thus, the various terms of these equations can be calculated from the data for the correlation of t_1 and t_2.

I have calculated the following for the successive ordinates of the alveolar arch:

	$[xy]$	$[xp]$	σ_3	r_{xy}	r_{xp}
$t_1\, t_2$	$+6.08$	$+1.67$	2.8	$+0.71$	$+0.28$
$t_1\, t_3$	$+5.03$	$+0.62$	2.3	$+0.67$	$+0.13$
$t_1\, t_4$	$+3.91$	-0.50	2.8	$+0.52$	-0.09
$t_1\, t_5$	$+2.70$	-1.71	2.9	$+0.38$	-0.27

In this table I have correlated the smallest dimension with each of the successively large dimensions as indicated by t. $[x^2]$ is taken as a constant; σ_3 appears to be constant. The correlation of t_{n-1} and P varies for different points in the curve OM, in such manner that two points may be found for which the correlation is zero. $[xp]$ varies with the magnitude of $[P]$, which in this curve is dependent upon the distance between t_1 and t_2.

I have no good data for a psychophysical test. The only available data, at this writing, are the reaction times in the Columbia University tests. To preserve the form of the preceding table the fifth reaction was taken as the point of departure. Thus:

	$[xy]$	$[xp]$	σ_3
$t_5\,t_4$	+ 7.78	— 8.00	4.8
$t_5\,t_1$	+ 4.13	— 11.63	4.9

The result is similar to that in the foregoing. $[xp]$ is negative with respect to consecutive trials. I have not calculated the values for all of the five trials because reaction time is not a good case; the distributions being asymmetrical, a disturbing factor is present. This will require special investigation.

These few observations lead to the following hypothesis: When a geometric form is taken as the type of biological activity the correlation between one dimension, taken as fixed, and its variation from another dimension will range indefinitely as positive or negative according to the geometric relations between the points from which the measurements are made. When two dimensions are correlated the degree of correlation will be increased or decreased by virtue of the equalization between the above correlation and the correlation between the parts common to both.

The method used by Spearman to determine the true correlation for psychological tests in which t_1 and t_2 seem to represent ordinates of a similar curve, assumes that $[pq]$ will be constant for the successive trials. Turning to our last formula and substituting

$$[pq] = [x^2] + [xp].$$

we have shown that $[xp]$ is a variable of uncertain range causing $[pq]$ to vary. Thus an unknown variable is introduced by the use of the Spearman formula. There is reason for assuming that $[xp]$ will be negative in many psychological tests, thus reducing $[pq]$, whence the method of Spearman will give correlations artificially increased.

To put it in another way, the formula of Spearman assumes that

$$r_{t_1t_2} = \frac{[pq]}{\sigma_1\sigma_2} = 1$$

or

$$= \frac{[pq]}{\sigma_1^2} = 1.$$

It is evident that this can be only when t_1 and t_2 are identical. $[pq]$ will be a constant when t_1 and t_2 are of the same type. We have shown above that the method of observation will sometimes result in a geometrical relation between t_1 and t_2 causing $[pq]$ to vary. Whenever this occurs the method fails.

CLARK WISSLER.

TREATMENT OF SIMPLE HARMONIC MOTION.

THE very great importance of simple harmonic motion in the physical world demands very careful consideration of the method of presenting and treating it for students beginning the work in advanced physics.

From the books on physics which I have at hand, I have selected fourteen which are used by a large portion of American students for their first study of simple harmonic motion. Eleven of these present and define simple harmonic motion merely as the projection on a diameter of uniform circular motion, deriving equations and other definitions by use of this uniform circular motion. Some of them scarcely suggest the question whether there really is such motion; much less, under what conditions or by what law of force it would occur.

Three of the fourteen texts give simple harmonic motion a *dynamic* definition, presenting it as produced by a force acting toward and varying as the distance from a center. But even these three, in treatment, make the *auxiliary circle* very prominent.

An experience of a good many years with large numbers of students leads me to believe that in the minds of very many the *auxiliary circle* with its functions and *circular motion* 'looms larger' than the actual simple harmonic motion. It seems to me highly desirable to dispense with the auxiliary circle in both definition and treatment.

The definition should be dynamic. This dynamic definition should be drawn from experiments.

The treatment should be a problem, a study of the motion caused by a force acting by the law found in the experiments.

I offer the following as an illustration of treating simple harmonic motion as above suggested; and for students not using calculus.

Experiments.—One or more on each, flexure,

elongation, torsion. Find the law of force and displacement, stress and strain.

Problem.—Find mathematical expressions for the motion of a free particle under such a law of force.

Take ee' as the path, with center c. Let h equal the acceleration at unit distance from c; and let the acceleration at any point in the path be directed toward c and vary as the distance from c.

$ce = a$, *amplitude.*

$ek = a.h$

$cp = x$, a variable, *displacement.*

then

$\frac{1}{2}a.a.h =$ work from e to c.

$\frac{1}{2}x\frac{x}{a}a.h =$ work from p to c.

$\frac{(a^2 - x^2)h}{2} =$ work from e to p.

$= \frac{1}{2}V^2$, velocity squared, if work was done on unit mass.[1]

$$V = \sqrt{h}\sqrt{a^2\left(1 - \frac{x^2}{a^2}\right)} = a\sqrt{h}\sin\theta,$$

$$\theta = \cos^{-1}\frac{x}{a}.$$

To construct this geomerically and determine the constant $a\sqrt{h}$.

For any point, p, with $cq = a$, construct θ pcq, by bringing q into the perpendicular from p.

Take qr perpendicular to cq, $= a\sqrt{h}$ on some scale (which need not be known).

On qr make the right triangle qsr, $r = \theta$.

Then $qs = a\sqrt{h}\sin\theta =$ velocity at p in the simple harmonic motion.

Let $T =$ the *period*, the time of a complete vibration, from e to e' and back to e; and let $t =$ any portion of time.

If cq is given a uniform angular velocity $2\pi/T$, that is, θ is made to vary uniformly with time, the component of q's motion parallel to p's path will at every instant equal the motion of p. The linear velocity of q, $2\pi a/T$, is equal to the constant $a\sqrt{h}$. θ is at any instant (reckoning time from leaving e) equal to $2\pi t/T$.

[1] Unit mass was taken to simplify work in getting the form of the equations. The relation of mass to simple harmonic motion should be determined and put in the formulæ. Though only two or three of the text-books under consideration make any allusion, even, to mass.

Hence, for velocity at point, p, in simple harmonic motion,

$$V = \frac{2\pi a}{T}\sin\frac{2\pi t}{T}.$$

From this the equation for acceleration can be obtained. Phase and epoch can be defined and introduced into the equations.

I. THORNTON OSMOND.

THE BRITISH ASSOCIATION AND AFFILIATED AND CORRESPONDING SOCIETIES.

THE report of the council of the British Association presented at the South African meeting the following resolution, from the conference of delegates, was referred to the council by the general committee for consideration and action, if desirable:

(i.) That a committee be appointed, consisting of members of the council of the association, together with representatives of the corresponding societies, to consider the present relation between the British Association and local scientific societies.

(ii.) That the committee be empowered to make suggestions to the council with a view to the greater utilization of the connection between the association and the affiliated societies, and the extension of affiliation to other societies who are at present excluded under regulation 1.

This resolution, having been referred to a committee, consisting of Dr. E. H. Griffiths, Sir Norman Lockyer, Professor Meldola, Mr. F. W. Rudler, Mr. W. Whitaker and the general officers, to consider and report thereon to the council, the committee made the following recommendations:

I. (i) "That any society which undertakes local scientific investigation and publishes the results may become a society *affiliated* to the British Association.

(ii.) "That the delegates of such societies shall be members of the general committee.

(iii.) "That any society formed for the purpose of encouraging the study of science, which has existed for three years and numbers not fewer that fifty members, may become a society *associated* with the British Association.

(iv.) "That all associated societies shall have the right to appoint a delegate to attend that annual conference, and that such delegates shall have all the rights of those appointed by the affiliated societies, except that of membership of the general committee."

II. The committee further recommend that the council request the corresponding societies committee—

(i.) "To collect information as to the societies of the United Kingdom who might become associated societies under rule 1.

(ii.) "To consider and report on the question of 'A Journal of Corresponding Societies' referred to in Principal Griffith's Report."

III. The committee also recommend—

"That the council, in nominating a chairman of the conference of delegates, should choose one of their own body."

On the recommendation of the corresponding societies committee, the following resolution, remitted to the committee and embodying subsequent amendments, has been adopted by the council:

BY-LAW.

I. (i.) "That any society which undertakes local scientific investigation and publishes the results may become a society *affiliated* to the British Association.

(ii.) "That the delegates of such societies, who must be or become members of the British Association, shall be *ex officio* members of the general committee.

(iii.) "That any society formed for the purpose of encouraging the study of science, which has existed for three years and numbers not fewer than fifty members, may become a society *associated* with the British Association.

(iv.) "That all associated societies shall have the right to appoint a delegate to attend the annual conference, and that such delegates shall be members or associates of the British Association, and shall have all the rights of those appointed by the affiliated societies, except that of membership of the general committee.

II. "That the corresponding societies committee be requested to collect information as to the societies of the United Kingdom who might become associated societies under rule I. (*corresponding societies*).

III. "That in nominating a chairman of the conference of delegates, rule VIII. (*corresponding societies*) be allowed to stand."

THE NEW MUNICH CLINIC.

THE completion of the new University Clinic in Munich for nervous and mental diseases marks an important epoch in the progress of humanity, no less than in the history of medicine. From the time when William Griesinger, forty years ago, planned the first modern hospital for the insane, the leading authorities in Germany have labored to perfect the plans and organization of institutions of this class, with the result that the Munich Hospital will serve for years to come as a model to be copied by other nations. Whether the clinic is judged by the opportunities it affords for the observation and treatment of nervous and mental diseases, by the provision it makes for the instruction of students or by the facilities it offers to those engaged in the scientific study of the brain, it stands unique. Without detracting from the remarkable advances made during the past fifty years in surgery, pathology and bacteriology, it may be affirmed that no greater progress has been recorded in the history of medicine than has occurred in psychiatry during the period that began when Pinel, in the wards of the Salpêtrière first removed the chains from the insane, and that culminated in Germany in the movement that has rendered possible the completion of the Munich Hospital. Nearly forty years have passed since university and state authorities in Germany, influenced largely by the teaching of Griesinger, realized that the study of the brain, with a view not only to the discovery of the means for the prevention of insanity, but also to determine the most efficient methods of increasing the power to think and act normally, includes the discussion of many problems as important to mankind as the enquiry concerning the origin and spread of infectious diseases or the growth of tumors. The plans for the hospital in question are not entirely of recent creation; they represent the experience gained in the construction of twenty-two hospitals of similar type which exist in the German empire, and of which not a single example is yet to be found in an English-speaking country.

As an excellent general description of this

clinic has been given in a consular report by Mr. Mason,[1] the American consul general in Berlin, and as a book containing detailed plans is soon to be issued by Barth, of Leipzig, only a few points of general interest will be referred to, here and now. The plot of ground on which the clinic stands was given by the city of Munich and is within a stone's throw of the other buildings which form the medical department of the university. The hospital building, which has accommodations for one hundred and ten bed patients, affords no evidence of money wasted in unnecessary architectural adornment, and yet is in excellent taste. The ground plan exhibits a central building and two L-shaped wings enclosing a small garden, at the back of which are the kitchens and laundries. In the central building are rooms for the examination of new patients; the out-patient department, or dispensary; an amphitheater with seating capacity for two hundred and forty students; a library, where the daily conferences of the staff are held; rooms for anatomical, pathological and psychological investigations; clinical and chemical laboratories; a brilliantly lighted room, where patients and specimens may be photographed—a room for photomicrography and apartments for the use of the six resident and two non-resident members of the medical staff.

In visiting the wards one is impressed with the fact that neither in the general plan, nor in the furnishing, is there anything which serves to recall the old asylum methods of treating patients. No form of mechanical restraint is used; even 'canvas jackets' and 'restraint sheets' are to be found only in the collection of articles which serve to illustrate the old-fashioned methods of treatment and nursing. The remarkable quiet of the patients, in spite of the fact that most of these are in the acute stages of their alienation, is due in large measure to opportunities afforded for keeping them in continuous baths, a form of treatment rendered possible only by the use of specially constructed baths and bath rooms. What follows will give an idea of the care and ingenuity shown in planning the details of the hospital. The night-nurses in each ward, when not attending patients, sit at a small table at which the light is so shaded that it can not possibly disturb any of the patients. Should the nurse desire, she can at any moment, without moving from her position, turn on one or all of the lights in the ward suddenly, or by means of a current controller, slowly; she can telephone to any member of the medical staff, and can, without leaving her seat, heat water or milk on a small electric stove. The keys to the light, the telephone, the stove, the register, which the nurse touches every half hour, the recording dial of which is in the room of the chief physician, are all concealed in niches in the wall, closed by small doors which can be opened only by the nurse's key.

An important preliminary to the actual treatment of patients is the ease with which new cases are admitted to the institution. In many instances patients are brought at their own request to the clinic or are sent to the wards directly from the out-patient department. Those who are dangerous either to themselves or the community and refuse to be detained may be held by the director of the clinic until sufficient time has elapsed to observe the case carefully, and then, if the patients still demurs to confinement, an appeal may be made to a justice, who at once appoints a committee of three to report upon the condition of the patient and the validity of the demurer.

Ample provision has been made for the teaching of students. In the out-patient department there are abundant facilities for the demonstration of the cases to small classes of students, while in the amphitheater every possible opportunity is afforded for the substitution of demonstration and object lessons for didactic lectures. Should it be necessary during a lecture to use the magic lantern, projection apparatus, epidiascope, or even the kinematograph, the brilliantly lighted room may be darkened by pressing a button, which starts an electric apparatus that lowers and raises heavy black curtains. The space de-

[1] Daily Consular Reports, No. 2264, May 22, 1905, Department of Commerce and Labor, Washington.

voted to the several departments in which research work is conducted is surprisingly large. The study of all questions bearing directly upon the anatomy and finer histology of the brain is carried on in a perfectly equipped laboratory. Two smaller adjoining rooms are reserved for the use of the director of the laboratory. Seven rooms are set apart for the use of those who are engaged in following lines of work in experimental psychology or physiology, while separate quarters have been assigned to both the clinical and chemical laboratories. Among the more interesting items of the new equipment noticed in the psychological department was an elaborate, but exceedingly ingenious, apparatus for the exact measurement of the pupillary reactions in response to light, sound and smell stimuli.

A word may be said with reference to the duties of the director of the clinic, who is also professor of psychiatry in the university. His word as to what patients shall or shall not be admitted to the clinic is final and he may, at any time he thinks proper, discharge or have a patient transferred to an asylum.

Although not forbidden to engage in private practise, it is expected that the director's time will be chiefly occupied in teaching students, supervising the work done in the various laboratories and in carrying on scientific investigations. The fact that professorships of psychiatry in Germany are in the true sense of the word academic positions, enables the director of a clinic to keep *au courant* with his profession, to have more time for study, and is thus fitted to be a more stimulating teacher and more intelligent investigator than is possible in those countries where the alienist devotes most of his energies to administrative duties or to private practise.

The incalculable advantage of having a director of a hospital who, not only by precept, but also by practise, encourages his assistants and students to undertake the solution of new problems is of the greatest importance.

The American who visits the Munich clinic and takes a comprehensive view of the great forward movement in medicine to which this institution is a monument may well ask himself the question, How long will our leading universities be without adequate means and opportunities for the organized systematic study of the most important organ of the body, whose functions professors and teachers seek to train? The most liberal contribution from a private individual that has yet been made in Germany to an institution devoted to the study of the brain was that of Herr Krupp, the maker of big guns. This far-sighted and philanthropic man saw that the time had come when the study of the brain of the man behind the guns was a matter of the greatest importance to the German empire, and with this aim in view he not only founded, but endowed, the Neurobiological Institute in Berlin. This institution has for its sole object the investigation of various problems connected with the structure and functions of the nervous system, and, although deserving a fuller description, is briefly referred to here, in order to direct attention to the widespread interest that these questions are receiving in Germany.

Stewart Paton.

STANDARD TIME IN AMERICA.

The annual report of the Superintendent of the U. S. Naval Observatory for 1904 has stated on page 14 that the adoption of the standard time system of this country is the outgrowth of the efforts of the naval officers on duty at that institution.

The more detailed history of this interesting subject is about as follows: The astronomers in charge of the numerous observatories of this country (usually connected with universities) have always felt the necessity of contributing their quota to the public welfare, and whenever possible have regulated the local public clocks and the time systems for the local railroads. This work began with the labors of W. C. Bond (1820–1860), whose private observatory in Boston developed into the magnificent Harvard College Observatory at Cambridge. Bond not only regulated the time furnished to the shipping in Boston and to jewelers and that shown by the public clocks, but also especially the clocks of the railroads centering in that city. About 1840 Professor O. M. Mitchell began to regulate from the Cincinnati Observatory the time used by the

railroads in that city, and the work was continued by Twitchell, Davis, Abbe, Stone and Porter. About 1855 the Dudley Observatory at Albany undertook the control of the time of the New York Central Railroad, and its work was kept up by Hough, the U. S. Signal Service and Boss. About 1867 the Allegheny Observatory began regulating the time of the railroads centering in Pittsburg, and Wadsworth and Keeler kept up this work of Langley. In Chicago, beginning with 1865, Professor T. H. Safford regulated the time system from the Chicago Observatory. About 1850 a time ball was established on the U. S. Naval Observatory at Washington, and by 1870 telegraphic communication had been established between it and some of the government buildings in that city. About 1880 the Yale College Observatory, under Dr. Leonard Waldo, established a bureau of standard time for the state of Connecticut.

In all the preceding cases each observatory sent out its own local mean time as the standard for local use, and also gave the railroads whatever standard time they might require for their use. Local standard times were also furnished to the vessels in the ports at Boston, New York, Washington and elsewhere, and the navigators obtained Greenwich time by adding the corresponding difference of longitude. At that date no one seems to have thought it practicable to distribute a uniform standard of time for public use.

In 1870 General A. J. Myer, in organizing the telegraphic service of the Weather Bureau, required that all observations and telegraphy for the tridaily weather maps should be done simultaneously on the time proper to the meridian of Washington, while another set of observations was kept up for climatological purposes on local time. In 1871 the simultaneous work was, by mutual consent, extended to the vessels at sea, and in 1873 to observers of all nations throughout the world; all simultaneous records that were made for the Signal Service and published in the Bulletin of International Observations were originally made at 7:30 A.M. Washington, or 12:43 P.M. Greenwich, standard time.

About 1878 corresponding simultaneous work was ordered to be done on the U. S. naval vessels. In the course of his study of observations of the aurora of April, 1874, Professor Abbe had occasion to state that much trouble arose from the fact that the numerous correspondents had used such a great variety of standards of time, many of which could not be identified at all; that the words 'railroad time,' 'local time,' or 'standard time' seemed to have no definite meaning, and that when several railroads passed near an observer it was really impossible to ascertain what particular railroad time was adopted by him. In May, 1875, he requested the president of the American Metrological Society, Dr. F. A. P. Barnard (president of Columbia University), to consider whether the reform of standard time could not properly engage the attention of that society. The society at once appointed Professor Abbe chairman of a committee to consider that subject, and his reports are published in the proceedings of the society for May, 1879, and subsequent years. The position was taken that Greenwich standard time and Greenwich longitude should be adopted. But before making the detailed report it seemed necessary to arouse public opinion on the subject, and numerous articles were published by himself and friends in the daily papers, monthly magazines and scientific journals. Eventually the full report of the committee, a pamphlet of twenty-seven pages, was published in May, 1879, in which the existing state of confusion and the beauty of a simple, practical system of standard meridians at even hours east or west of Greenwich were set forth.

It recommended most positively the schedule of standard hour meridians now in use; it also urged that one standard would be still better and equally practicable. The publication of this report brought out the fact that Professor Charles F. Dowd, Mr. Sanford Fleming and Mr. W. F. Allen, secretary of the General Time Convention of Railroad Officials, had also thought along similar lines. It was evident that such a radical change from current practise could best be initiated by the railroad companies as the committee had reported. Accordingly, after a consider-

able discussion in the public press, which the committee encouraged in order to bring out all possible objections and as a matter of public education, it requested the president of the Metrological Society to recommend the suggestions in this report to the consideration of the General Time Convention.

Mr. Allen now took up the subject with renewed energy. By two years of intense discussion and correspondence he was able to enlist the majority of the railroads in support of the Greenwich hour system. The success of the reform rested wholly with him. President Barnard distributed widely the various circulars of the American Metrological Society on standard time. The chief signal officer, General William B. Hazen, adopted the idea of the proposed reform with the greatest enthusiasm. The signal office had already found it necessary to instruct some of its men in the astronomical methods of determining time, and its observers at Dudley Observatory and elsewhere, in addition to their regular meteorological duties, were now regulating local time and even local railroad time when no special astronomers were available for that purpose. In order that the standard of time sent to signal service observers daily should be correct to the nearest second, so that such miscellaneous observations as atmospheric electricity, auroras, thunder storms, earthquakes, meteors, might not be deficient in accuracy, Professor Frank Waldo suggested the plan and General Hazen authorized what might be called a general clearing house for all the astronomical observatories that wished to cooperate with him. It was arranged that an early morning signal should be telegraphed, say at 11 A.M., and automatically recorded by the chronograph and clock of the Signal Service at Washington. Among these signals some would always be very accurate because the respective observatories had clear weather and had just made a good time determination during the preceding night, while others would be relatively inaccurate because of cloudy weather at the respective localities where the observatories had been necessarily relying upon their clock rates for several days. By combining all these into one general mean giving appropriate weights it thus became possible to send back to each observatory a statement as to how much its own clock was in error as compared with the mean of all throughout the country. Such a beautiful system as this might with propriety have been inaugurated by any astronomical observatory, but an extensive correspondence had shown that the signal service was the only institution with which all the observatories and astronomers were disposed to cooperate in this work.

That some such plan was, and is now, desirable is shown by the fact that a comparison of the standard time signals of the U. S. Naval Observatory, the Harvard College Observatory and the Alleghany Observatory, made each day during several years at New York by the Western Union Telegraph Company, showed large differences, amounting to as much as five seconds in some few cases and frequently exceeding two seconds.

Unfortunately, however, in 1884, shortly before the clearing-house system was to go into operation, some evil-minded person seems to have induced the secretary of the navy to believe that the Signal Service, in its desire to secure accurate time, was exceeding its own legitimate duties, and an order came from the secretary of war forbidding further action, and even requiring the removal of the elegant clock from its ideal location in the basement of the War Department building. This was the first clock in this country to be so mounted that the air pressure and the air temperature to which it was subjected would remain constant. The country was thus deprived, at least temporarily, of the prospect of obtaining the most accurate possible time service for the use of both astronomers and the public, and the U. S. Naval Observatory continued its struggle against the use of standard hour meridians.

Meantime, however, Mr. Allen had induced the railroads to agree that his standard hour system should go into effect on the eighteenth of November, 1883. In order to realize this result it was necessary that the observatories giving time to the railroads and local communities should change to the new system of hour meridians. This change in public clocks and

by the railroads was to be made during the morning of the eighteenth, but a few days before that Mr. Allen wrote Professor Abbe, saying that he feared some embarrassment if the Harvard College Observatory should fail to change its public time signals, as the director of the observatory was absent from the country. Accordingly, a telegram from General Hazen to President Eliot urged that by reason of its eastern longitude Harvard College and New England should have the honor of thus beginning the desired reform. The people as well as the railroads of New England began the good work on that Sunday morning.

By an agreement with the Western Union Telegraph Company, made about 1877, that company sold its time signals received from the Naval Observatory to its customers throughout the country who would pay for them. This was, probably, the only case in which a government institution cooperated with a corporation to sell that which would seem to be government property and without any return to the Treasury. Of course the telegraph companies made equivalent returns to the government by allowing the free use of their lines for longitude purposes, but it seemed rather hard that this last concession, which had been in effect since 1845, should be used as an argument for maintaining a popular distribution of time signals that cut under or competed with the work of local astronomical observatories. Of course on November 18, 1883, at the request of the telegraph company the Naval Observatory began sending signals on the 75th standard for transmission to the railroads, but its own time-balls and signals for use in Washington city continued to be regulated by Washington local mean time until March 1, 1884.

In conclusion it may safely be said that the adoption of the present system of standard hours, with all its manifold advantages, has been accomplished by persons outside the government service. The officials of our railroads have lately united in ascribing the successful introduction of standard time to Mr. W. F. Allen, without saying a word in favor of the Naval Observatory's pretensions.

SCIENTIFIC NOTES AND NEWS.

Dr. George F. Kunz, of New York City, has been appointed by the State Department a delegate to the International Congress for the Study of Radiology and Ionization, which will be held in Liège, Belgium this month.

We learn from the *American Geologist* that Professor T. C. Chamberlin has been appointed a member of the Illinois Geological Survey Board. The other members are *ex-officio* Governor Deneen and President James, of the State University.

Mr. E. C. Chilcott, agronomist of the South Dakota Agricultural Experiment Station, has been appointed expert in connection with the cereal work of the Department of Agriculture.

Dr. Walter Schiller has been appointed head of the geological division of the Museo de la Plata and geologist of Buenos Ayres.

On the occasion of the installation of Mr. Andrew Carnegie as lord rector of St. Andrew's University on October 17, the university will confer the honorary degree of doctor of laws on Mr. Carnegie; Mr. Whitelaw Reid, the American ambassador to Great Britain; Mr. Charlemagne Tower, the American ambassador to Germany; Bishop Potter of New York; Dr. Nicholas Murray Butler, president of Columbia University, and Dr. William J. Holland, director of the Carnegie Museum at Pittsburg.

A memorial in honor of Professor Friedrich von Esmarch, the eminent surgeon of the University of Kiel, has been erected in his native place, Tönningen in Schleswig-Holstein. Professor von Esmarch was present at the unveiling, which took place on August 6.

M. Vidal de la Blache has received the medal of the Paris Geographical Society in recognition of his work, 'Tableau de la Géographie de la France,' which is the introduction to the 'Histoire de France,' published under the direction of M. E. Lavisse.

Secretary Wilson has made public the report of Solicitor George P. McCabe on the investigation of the charge that Dr. Daniel E. Salmon, head of the Bureau of Animal

Industry, was improperly interested in the firm of George E. Howard and the Howard Label Company. Secretary Wilson's indorsement on the report is as follows: "Inquiry discloses the fact that Dr. Salmon had an unfortunate connection with the firm of George E. Howard & Co. While this connection was not an ideal relation for a government officer to have with a firm doing business with the department, I am convinced that Dr. Salmon never intended to profit by work done by Mr. Howard for the Department of Agriculture, and that he has never been connected with the Howard Label Company or received any benefit from the contract of that company with the department. The action of the department regarding the meat inspection service was as fair, considerate and comprehensive as the appropriations would warrant. The case does not seem to call for further disciplinary action."

THE statement which we quoted from the *American Geologist* in regard to the change in the directorship of the Geological Survey of Michigan was incorrect. In regard to the survey, we are informed that the director, Professor A. C. Lane, is engaged in detailed studies in the copper region. Professor I. C. Russell is making an examination of the surface geology in the Upper Peninsula, and Mr. Frank Leverett, of the United States survey, is studying the same problem. They are working in cooperation. Professor C. A. Davis is studying the development and ecology of the peat bog flora. Mr. W. C. Gordon is completing a cross section of the copper-bearing formation to determine the different horizons near the Wisconsin line. Professor W. M. Gregory is finishing his report on Arenac County. Mr. W. F. Cooper is working on the Wayne County report and watching the shaft going down to rock salt, near Detroit.

PLANS for the cooperative investigation of the artesian waters in the vicinity of Wilmington, North Carolina, have been arranged by the United States Geological Survey and the State Geological Survey of North Carolina. It is expected that the work will be in charge of Mr. M. L. Fuller, who will be assisted by Mr. L. W. Stephenson, of Johns Hopkins University, and Mr. B. L. Johnson, recently of the Massachusetts Institute of Technology.

CHARLES E. BROWN, curator of the Wisconsin Archeological Society, has returned from a week in the field plotting mounds and collecting archeological data in the vicinity of Beaver Dam and Fox Lakes in the western part of Dodge County, Wisconsin, and is now preparing the society's exhibit of archeology for the state fair.

ON August 9 the London County Council erected a tablet on the house in which Edward Jenner, the discoverer of vaccination, lived during 1803.

IT is proposed to erect a memorial to the late Professor Emerich Meissl in the agricultural experiment station at Vienna, with which he was connected for more than twenty years.

PROFESSOR ELLIS A. APGAR, for twenty years state superintendent of public instruction in New Jersey and a writer on botany, died at East Orange, N. J., on August 28.

DR. ROBERT BILLWILLER, director of the Swiss Meteorological Bureau, died in Zurich on August 14, at the age of fifty-six years.

IT appears from cable despatches to the daily papers that the weather was very favorable for observations and photographs of the total solar eclipse on August 30 for the large number of parties of different nationalities that went to Spain, Algeria, Tunis and Egypt. The weather was unfavorable on the Island of Majorca. In this country the partial eclipse was obscured by clouds.

REUTER'S AGENCY telegraphs that members of the British Association arrived at Durban on August 22. They proceeded to Pietermaritzburg on August 24, where they were welcomed by the governor of Natal. A number of excursions were made on the twenty-fifth, and the members left for Colenso on the twenty-sixth.

THE seventy-seventh meeting of German Men of Science and Physicians was held in Meran last week under the presidency of Dr. Franz von Winckel, professor of gynecology

at Munich. At the general sessions papers were presented by Professor W. Wien, of Würzburg, on 'Electrones'; Professor Nocht, of Hamburg, on 'Tropical Diseases'; Professor H. Molisch, of Prague, on 'The Reaction of Plants to Light'; Professor H. Dürck, of Munich, on 'Beri-Beri'; Dr. Cl. Neisser, of Lublinitz, on 'Individuality and Psychoses'; and by Professor J. Wimmer, of Vienna, on the 'Mechanics of the Development of Animals.' At a meeting of the entire association papers on heredity were presented by Professor C. Correns, of Leipzig; K. Heider, of Insbruck, and B. Hatschek, of Vienna. The association met in thirty sections for the reading of scientific papers, of which seventeen were in medicine and thirteen in natural science, the latter being as follows: (1) Mathematics, astronomy and geodesy; (2) physics; (3) applied mathematics and physics; (4) chemistry; (5) applied chemistry; (6) geophysics and meteorology; (7) geography; (8) mineralogy, geology and paleontology; (9) botany; (10) zoology; (11) anthropology, ethnology and archeology; (12) mathematical and scientific education; (13) pharmacology.

THE sixth Congress of Criminal Anthropology will meet at Turin on April 28, 1906, under the presidency of Professor Lombroso. An exhibition of criminal anthropology will be held in connection with the congress.

THE nineteenth annual convention of the Association of American Agricultural Colleges and Experiment Stations will be held at Washington, D. C., in the early part of November next.

THE Sank County Historical Society has been organized, in Wisconsin, to further archeological and historical research, by Messrs. A. B. Stout and H. E. Cole, members of the Wisconsin Archeological Society.

FROM June 21 to 26, 1906, a large agricultural exposition is to be held at Berlin, which will also comprise a special division for preserved-food articles, such as products of the dairy, dough, potatoes, fruits, wines and extracts, meats, beer, etc. Money prizes, diplomas and medals will be awarded. In order to test the preserving capacity of these exhibits they will be sent to the tropics.

UNIVERSITY AND EDUCATIONAL NEWS.

BY direction of the late Mrs. Adolphus F. Eliott, a hospital, to cost $175,000, has been given to the University of Minnesota.

THE University of Melbourne attains its jubilee next year, and preparations are already in progress to celebrate the event.

THE board of Trinity College, Dublin, has instituted a diploma in economics and commercial knowledge. The course for the examination includes, as obligatory subjects, the theory of economics, commercial history and geography, accountancy and commercial law; and as optional subjects a modern language (French or German or Spanish), any one of a variety of special economic subjects, and any one of the following branches of economic and business organization—banking, railways, insurance, agriculture.

THE summer course in experimental phonetics at the University of Marburg was delivered this year by Dr. E. W. Scripture. The course had been previously given by the Abbé Rousselot, of the Collège de France, Paris.

MR. SAMUEL M. KINTNER, for some years professor of electrical engineering at the Western University of Pennsylvania, has been appointed associate professor of electrical engineering in the Carnegie Technical School.

MR. W. P. BROOKS has been appointed director of the Massachusetts Agricultural College and Experiment Station, in succession to the late Henry Hill Goodale.

M. LAVASSEUR, the statistician, has succeeded M. Gaston Paris as executive head of the Collège de France.

DR. VERNEUIL and Dr. Rosenstiehl have been appointed professors of applied chemistry in the National Conservatory of Arts and Measures. Dr. Deperet has been appointed professor of geology and mineralogy in the faculty of sciences at the University of Lyons and Dr. Rivals professor of technical chemistry at Aix-Marseilles.

SCIENCE

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CONTENTS.

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES.

THE figures in the accompanying table, which have been obtained from official sources, show that in the course of the past eight years the degree of doctor of philosophy or doctor of science has been conferred on 2,037 students by thirty-five American universities. This record is tolerably complete, for although the degree

TABLE I.

DOCTORATES CONFERRED.

	1898	1899	1900	1901	1902	1903	1904	1905	Total
Chicago	36	24	37	36	27	32	36	44	272
Yale	34	30	26	39	29	36	39	34	267
Harvard	26	24	36	29	31	28	46	38	258
Johns Hopkins	33	38	33	30	17	23	31	35	240
Columbia	22	33	21	25	32	39	29	38	239
Pennsylvania	24	20	15	25	14	29	18	26	171
Cornell	19	7	19	21	23	20	13	21	143
Clark	12	5	9	7	1	4	10	18	66
Michigan	7	4	5	3	10	10	8	7	54
New York	5	9	7	6	4	4	9	7	51
Wisconsin	5	7	5	5	6	2	10	9	49
Boston	0	0	0	0	0	4	7	14	25
Virginia	0	2	2	8	6	3	1	1	23
George Washington	1	0	5	3	2	4	3	3	21
Minnesota	1	2	3	2	3	3	3	3	20
California	1	3	2	2	1	3	3	4	19
Brown	1	3	3	2	2	5	0	2	18
Bryn Mawr	3	3	1	2	2	0	5	2	18
Princeton	0	3	3	3	1	1	2	5	18
Stanford	2	0	2	2	2	1	1	1	11
Nebraska	2	1	1	1	0	0	2	3	10
Georgetown	0	0	0	0	0	3	1	2	6
Washington	0	2	0	1	0	1	1	0	5
Iowa	0	0	0	0	0	2	0	2	4
North Carolina	0	0	0	0	2	1	0	1	4
Vanderbilt	0	0	3	1	0	0	0	0	4
Cincinnati	0	0	0	0	0	1	1	1	3
Colorado	0	1	0	0	0	0	2	0	3
Kansas	0	1	0	0	0	2	0	0	3
Lafayette	0	0	0	0	0	3	0	0	3
Missouri	0	1	0	0	0	0	0	2	3
Lehigh	0	0	0	0	0	2	0	0	2
Syracuse	0	1	0	0	1	0	0	0	2
Illinois	0	0	0	0	0	0	0	1	1
Tulane	0	0	1	0	0	0	0	0	1
	234	224	239	253	216	266	281	324	2037

has been conferred by other institutions, but few of them have proper facilities for research. The table shows that 324 degrees were conferred this year, a considerable increase over 1904 and over any preceding year. During the first five years covered by these records there was no increase in the number of degrees, the average being 233. In 1903 there was a gain of 33 above this average, in 1904 of 48, and this year of 91. The increase in the present year is satisfactory, and if maintained may supply the demand for those competent to carry on research work. An average increase of about twelve degrees a year for the past seven years is, however, small, not in proportion to the increase in the number of graduate students or of academic and other positions where competence in research is a qualification. It is further probable that the number of degrees given to American students by German universities has decreased during this period.

Attention has been called on previous occasions to the large percentage of degrees conferred by a few institutions. There is, however, a slight tendency, that will probably become more marked, for the gap between the seven institutions at the head of the list and those below to be filled in. The fact that Boston University this year conferred 14 degrees is probably exceptional, but the nine degrees conferred by the University of Wisconsin are more likely to be increased than diminished in subsequent years. Several institutions of the central and western states, of which California and Wisconsin may be especially mentioned, have greatly improved their facilities for graduate work during the period covered by these statistics. Up to the present time the universities fall into rather well-marked groups. Chicago, Yale, Harvard, Johns Hopkins and Columbia have, in the course of the past eight years, each conferred about 250 degrees; Pennsylvania and Cornell about 150; Clark, Michigan, New York and Wisconsin about 50; Boston, Virginia, George Washington, Minnesota, California, Brown, Bryn Mawr and Princeton about 20; Stanford and Nebraska about 10.

The University of Chicago gave this year 44 doctor's degrees, of which 21 were in the sciences, and these figures place Chicago at the head of both lists, it surpassing Yale as the university which up to last year had conferred the greatest number of degrees, and the Johns Hopkins University, which up to last year had conferred the greatest number of degrees in science. Clark University this year conferred as many as 18 degrees, all in the sciences, and Boston University conferred 14 degrees, none of which were in the sciences.

TABLE II.

DOCTORATES CONFERRED IN THE SCIENCES.

	1898	1899	1900	1901	1902	1903	1904	1905	Total	Per Cent.
Chicago	12	13	19	16	15	21	14	21	131	48
Johns Hopkins	19	17	20	19	9	10	17	18	129	53
Columbia	10	23	12	13	14	18	11	20	121	51
Harvard	11	7	15	15	14	15	23	12	112	43
Yale	11	15	10	18	10	13	15	13	105	39
Cornell	11	2	11	13	16	13	8	13	87	61
Pennsylvania	8	8	6	12	5	14	9	12	74	43
Clark	12	5	9	7	1	4	10	18	66	100
Wisconsin	2	4	1	3	4	0	4	3	21	43
Michigan	0	3	1	0	5	4	6	?	19	35
California	1	3	1	2	1	3	2	3	16	84
George Washington	1	0	3	1	1	4	1	3	14	67
Brown	1	0	0	1	2	4	0	2	10	56
Bryn Mawr	1	2	1	2	1	0	2	0	9	50
Princeton	0	3	1	0	0	1	1	3	9	50
Virginia	0	2	0	4	1	2	0	0	9	39
Nebraska	2	1	1	1	0	0	1	2	8	80
Stanford	2	0	0	1	2	1	1	1	8	73
Minnesota	0	1	1	0	2	1	0	1	6	30
New York	1	1	0	1	0	0	1	1	5	10
Washington	0	2	0	1	0	1	1	0	5	100
Iowa	0	0	0	0	0	1	0	2	3	75
Kansas	0	1	0	0	0	2	0	0	3	100
North Carolina	0	0	0	0	2	1	0	0	3	75
Lehigh	0	0	0	0	0	2	0	0	2	100
Missouri	0	1	0	0	0	0	0	1	2	67
Vanderbilt	0	0	1	1	0	0	0	0	2	50
Cincinnati	0	0	0	0	0	0	0	1	1	33
Colorado	0	1	0	0	0	0	0	0	1	33
Georgetown	0	0	0	0	0	0	1	0	1	17
Lafayette	0	0	0	0	0	1	0	0	1	33
Syracuse	0	0	0	0	1	0	0	0	1	50
	105	115	113	131	106	136	128	150	984	48

Table II. shows the number of degrees that have been conferred in the natural and exact sciences by the several institutions. The last column gives the per cent. of doctor's degrees in the sciences that each institution has conferred. It is thus seen that the study of the natural sciences is relatively emphasized in certain institutions, some universities conferring more than half the degrees in the sciences and others less than half.

The third table gives the degrees conferred in each of the sciences. Chemistry maintains the position of having more than twice as many doctorates as physics, which stands next on the list. Psychology this year passes zoology, and mathematics makes a considerable gain.

TABLE III.

DOCTORATES CONFERRED IN THE SCIENCES.

	1898	1899	1900	1901	1902	1903	1904	1905	Total
Chemistry	27	32	26	28	26	33	33	36	241
Physics	11	7	15	23	12	14	17	14	113
Psychology	18	15	9	13	8	16	10	21	110
Zoology	12	11	11	15	16	12	15	15	107
Mathematics	11	13	11	18	8	7	13	20	101
Botany	11	11	12	8	11	9	17	15	94
Geology	6	5	5	10	6	10	7	4	53
Physiology	4	1	4	1	8	8	1	3	30
Astronomy	3	2	4	5	2	4	4	3	27
Education	0	5	8	2	1	2	0	6	24
Sociology	0	5	3	3	4	2	1	1	19
Paleontology	0	4	2	1	0	2	2	3	14
Bacteriology	0	1	1	1	1	3	3	0	10
Anthropology	2	0	2	1	0	1	2	1	9
Agriculture	0	0	0	0	2	2	2	2	8
Engineering	0	0	0	1	0	3	1	3	8
Anatomy	0	0	0	1	0	4	0	0	5
Mineralogy	0	2	0	0	1	1	0	1	5
Pathology	0	0	0	0	0	3	0	0	3
Geography	0	0	0	0	0	0	0	1	1
Metallurgy	0	0	0	0	0	0	0	1	1
Meteorology	0	1	0	0	0	0	0	0	1
	105	115	113	131	106	136	128	150	984

The institutions that conferred three degrees or more in special subjects are as follows: *Chicago*—botany, 7; chemistry, 4; mathematics, 4. *Johns Hopkins*—chemistry, 7; physics, 3; zoology, 3. *Columbia*—education, 6; psychology, 5. *Harvard*—chemistry, 4; psychology, 4. *Yale*—chemistry, 6. *Clark*—psychology, 9; physics, 4; mathematics, 4. *Pennsylvania*—chemistry, 5; mathematics, 3.

The names of those on whom the degree was conferred in the natural and exact sciences, with the subjects of their theses, are as follows:

UNIVERSITY OF CHICAGO.

Maxwell Adams: 'On Some Derivations of Hydroxylamine.'

Frederick Lendall Bishop: 'The Thermal Conductivity of Lead.'

Edwin Bayer Branson: 'The Structure and Relationships of the American Labyrinthodontidæ.'

Orville Harry Brown: 'The Effects of Certain Salts on Kidney Excretion with Special Reference to Glycosuria.'

William McAfee Bruce: 'The Oxygen Ethers of Urea.'

Mintin Asbury Chrysler: 'The Development of the Central Cylinder in Araceæ and Liliaceæ.'

Nellie Esther Goldthwaite: 'On Cyanocetic Ether.'

Heinrich Hasselbring: 'Certain Problems of Assimilation.'

Clifton Durant Howe: 'Reforestation on the Colchester-Essex Sand Plains.'

Lynds Jones: 'The Development of the First Down and its Relation to the Definitive Feather.'

Herbert Edwin Jordan: 'Group Characters of Various Types of Linear Groups.'

William Jesse Goad Land: 'A Morphological Study of *Thuja*.'

William Burnet McCallum: 'Regeneration and Polarity in Plants.'

Thomas Emery McKinney: 'Concerning a Certain Type of Continued Fractions depending upon a Variable Parameter.'

Robert Lee Moore: 'Sets of Metrical Hypotheses of Geometry.'

Horatio Hackett Newman: 'The Morphogeny of the Chelonian Carapace.'

Alfred Reginald Schultz: 'The Underground Water Supply of Wisconsin, Northern Illinois and the Northern Peninsula of Michigan.'

Etoile Bessie Simons: 'A Morphological Study of *Sargassum Filipendula*.'

Arthur Whipple Smith: 'The Symbolic Treatment of Differential Geometry.'

Oswin William Wilcox: 'A Study of Ethylchlorsulphorate.'

Robert Bradford Wylie: 'The Morphology of *Elodea Canadensis*.'

YALE UNIVERSITY.

Harold Cornelius Bradley: 'The Physiology of the Gastropod *Sycotypus Canaliculatus*.'

Howard Stanley Bristol: 'Researches in Organic and Inorganic Chemistry.'

James Brown: 'The Interaction of Hydrochloric Acid and Potassium Permanganate in the Presence of Various Inorganic Salts.'

Charles Paxson Flora: 'The Estimation of Cadmium.'

Beverly Waugh Kunkel: 'Studies on the Anatomy of the California Limbless Lizard, *Auniella Pulchra*, with a General Consideration of the Pineal Apparatus of the Vertebrates.'

Bertram Augustus Lenfest: 'Thé Accuracy of Linear Movements.'

Raymond Benedict McClenon: 'On Simple Integrals with Variable Limits.'

George Grant MacCurdy: 'The Eolithic Problem: Evidences of a Rude Industry antedating the Paleolithic.'

Ralph Nelson Maxson: 'The Estimation of Small Amounts of Gold.'

James Caddall Morehead: 'Numbers of the Forms 2. $q = 1$ and Fermat's Numbers.'

Percy Edward Raymond: 'A Tropidoletus Faunule at Canandaigua Lake, N. Y. The Chazy Formation and its Fauna.'

Frederick Clark Stanley: 'A Critical Study of the Composition of Hornblende.'

Joannes Gabriel Statiropoulos: 'Researches in Organic Chemistry.'

HARVARD UNIVERSITY.

Bird Thomas Baldwin: 'The Mutual Influence of Different Starting Points on the Series of Associations.'

Gustavus Edward Behr, Jr.: 'Changes in the Free Energy of Iron under Varying Conditions.'

Maulsby Willett Blackman: 'The Spermatogenesis of *Scolopendra heros*.'

Howard Lane Blackwell: 'Dispersion in Electric Double Refraction.'

Latham Clarke: 'Addition Compounds of Dimethylaniline.'

George Shannon Forbes: 'Energy Changes involved in the Dilution of Zinc and Cadmium Amalgams.'

Walter Burton Ford: 'On the Problem of Analytic Extension as applied to Functions defined by Power Series.'

Charles Hughes Johnston: 'A Psychological Study of the Mutual Influence of Feelings.'

Herbert Adolphus Miller: 'The Race Problem and Psychophysics.'

Amon Benton Plowman: 'The Comparative Anatomy and Phylogeny of the Cyperaceæ.'

Frederick William Russe: 'On Tetrabromorthobenzoquinone.'

Clement Leslie Vaughan: 'The Motor Power of Optical Stimulations of Different Degrees of Complexity.'

JOHNS HOPKINS UNIVERSITY.

Eugene Cook Bingham: 'The Conductivity and Viscosity of Solutions of Certain Salts in Mixtures of Acetone with Methyl Alcohol and Ethyl Alcohol and Water.'

Hamilton Bradshaw: I., 'Relative Rates of Oxidation of Ortho, Meta and Para Compounds.' II., 'Orthosulphaminebenzoic Acid and Related Compounds.' III., 'Some Derivatives of Phenylglycocollorthosulphonic Acid.'

Philip Howard Cobb: 'A Further Investigation of the Chlorides of Orthosulphobenzoic Acid.'

Eugene Willis Gudger: 'The Breeding Habits and the Segmentation of the Egg in the Pipefish, *Siphostoma Floridæ*.'

August Ernest Guenther: 'A Study of the Comparative Effects of Solutions of Potassium, Sodium and Calcium Chlorides on Skeletal and Heart Muscle.'

William Edwin Hoffman, Jr.: 'Camphoroxalic Acid Derivatives.'

Robert Edward Loving: 'The Arc in High Vacua.'

William John Miller: 'The Crystalline Limestones of Baltimore County, Maryland.'

Henry Bayard Phillips: 'Some Invariants and Covariants of Ternary Collineations.'

James Temple Porter: 'Selective Reflection in the Infra-red Spectrum.'

Samuel Rittenhouse: 'The Embryology of *Stomotoca Apicata* and the Embryology of *Turritopsis Nutricula*.'

Forrest Shreve: 'The Development and Anatomy of *Sarracenia Purpurea* L.'

Roswell Powell Stephens: I., 'On a Curve of the Fifth Class.' II., 'On a System of Parastroids.'

Henry Philip Straus: 'An Electrolytic Method for the Preparation of Pure Caustic Alkalies for the Laboratory.'

Levi Shoemaker Taylor: 'An Electrical Method for the Combustion of Organic Compounds.'

Mayville William Twitchell: 'The Cenozoic Cassiduloidea of the United States.'

Horace Scudder Uhler: 'Absorption Spectra of the Aniline Dyes.'

Augustus Price West: 'A Study of the Effect of Temperature on Dissociation and on the Tempera-

ture Coefficients of Conductivity in Aqueous Solutions.'

COLUMBIA UNIVERSITY.

Felix Arnold: 'The Psychology of Association.'

Charles Josephus C. Bennett: 'Formal Discipline.'

Jesse Dismukes Burks: 'Exact Methods in City School Administration.'

Emily Matilda Coddington: 'The Historical Development of Pseudo-spherical Surfaces.'

Ellwood Patterson Cubberley: 'Equalization of the Advantages of Education by Means of State Aid.'

Frederick Morgan Davenport: 'A Sociological Study of Revivals.'

Walter Fenno Dearborn: 'The Psychology of Reading.'

Edward Charles Elliott: 'A Fiscal Study of Municipal School Administration.'

Roland McMillan Harper: 'A Phytogeographical Sketch of the Altamaha Gut Region of the Coastal Plain of Georgia.'

Linville Laurentine Hendren: 'The Rate of Recombination of the Ions in Gases at Low Pressures.'

Vivian Allen Charles Henmon: 'The Time of Perception as a Measure of Differences in Sensations.'

Howard Daniel Marsh: 'The Diurnal Course of Human Efficiency.'

Junius Lathrop Meriam: 'Studies in Normal Schools and Elementary Teachers.'

Henry Raymond Mussey: 'The Production of Iron Ore in the United States.'

Bruce Ryburn Payne: 'A Comparative Study of the Content and Time Allotments of the Curricula of Public Elementary Schools in Cities of the United States, England, Germany and France.'

George Drayton Strayer: 'City School Expenditures; the Variability and Interrelation of the Principal Items.'

Satoru Tetsu Tamura: 'A Mathematical Theory of the Nocturnal Cooling of the Atmosphere near the Earth's Surface.'

Ida Carleton Thallon: '*Lycosura* and *Damophon*.'

Lorande Loss Woodruff: 'An Experimental Study on the Life-History of Hypotrichous Infusoria.'

Naohidé Yatsu: 'Studies on the Embryology and Cytology of *Cerebratulus lacteus*.'

UNIVERSITY OF PENNSYLVANIA.

Clarence William Balke: 'Double Fluorides of Tantalum.'

Matthew Hume Bedford: 'Columbates.'

Alice Lenore Davison: 'The Electrolytic Determination of Cadmium with the Use of a Rotating Anode.'

Henry Fox: 'The Pharyngeal Pouches and Their Derivatives in the Mammalia.'

Robert Harvey Gault: 'On Conditions Affecting the Maximal Rate of Voluntary Extensor and Flexor Movements of the Right Arm.'

Oliver Edmunds Glenn: 'The Determination of the Abstract Groups of Order p^2qr, p, q and r being Distinct Primes.'

Ulysses Sherman Hanna: 'The Bitangentials of the Plane Quintic and Plane Sextic.'

Robert Harbison Hough: 'On the Mechanical Equivalent of the Heat of Evaporation of Water.'

Alice Madeleine McKelden: 'Groups of Order 2^m that Contain Cyclic Subgroups of Orders 2^{m-1}, 2^{m-2}, and 2^{m-3}.'

Burnett Smith: 'Senility Among Gastropods.'

Ralph Ogden Smith: 'The Rapid Determination of Lead and Mercury in the Electrolytic Way.'

James Renwick Withrow: 'The Electrolytic Precipitation of Gold with the Use of a Rotating Anode and the Rapid Analysis of Halides.'

CORNELL UNIVERSITY.

Oscar Perry Akers: 'On the Congruence of Axes in a Bundle of Linear Complexes.'

James Munsie Bell: 'Dineric Equilibria.'

Ralph Vary Chamberlin: 'North American Spiders of the Family Lycosidæ.'

Samuel Richard Cook: 'On the Velocity of Sound in Gases, and the Ratio of the Specific Heats, at the Temperature of Liquid Air.'

William Chauncey Geer: 'Contributions to the Chemistry of Indium.'

George David Hubbard: 'The Geographic Influence of the Precious Metals in the Development of the United States.'

Frederick Edward Kester: 'The Joule-Thomson Effect in Certain Gases.'

Charles Edward Lewis: 'The Embryology and Development of *Riccia lutescens* and *Riccia chystallina*.'

Richard Roswell Lyman: 'The Flow of Water over Weirs.'

Donald Alexander MacRae: 'Life of Sophocles, from the Sources.'

Addams Stratton McAllister: 'Alternating Current Commutator Motors.'

Herman Campbell Stevens: 'A Plethysmographic Study of Attention.'

George Frederick Warren, Jr.: 'The Apple Industry of Wayne and Orleans Counties, N. Y.'

Gershom Franklin White: 'The Bacterial Flora of the Apiary with Special Reference to Bee Diseases.'

CLARK UNIVERSITY.

Reginald Bryant Allen: 'On Hypercomplex Number Systems Belonging to an Arbitrary Domain of Rationality.'

Charles E. Browne: 'A Study of the Simpler Arithmetical Processes.'

W. Fowler Bucke: 'Examinations and Grading.'

Arthur L. Clark: 'Surface Tension at the Interface between Certain Liquids and Vapors.'

Joseph George Coffin: 'Construction and Calculation of an Absolute Standard of Self-Inductance.'

John Shaw French: 'On the Theory of the Pertingents to a Plane Curve.'

Jesse Nevin Gates: 'Cubic and Quartic Surfaces in Four-fold Space.'

Benjamin Spencer Gowen: 'Group Psychoses.'

John Charles Hubbard: 'On the Conditions for Sparking at the Break of an Inductive Circuit.'

Herbert G. Keppel: 'The Cubic Three-spread Ruled with Planes in Four-fold Space.'

Walter Libby: 'Poetic Imagination.'

Thomas Scott Lowden: 'A Study in Personal Hygiene.'

Josiah Moses: 'Pathological Aspects of Religion.'

Fred Mutchler: 'A Study of the Structure and Biology of the Yeast Plant.'

Maurice Herman Small: 'On Some Psychical Relations of Society and Solitude.'

Lewis Madison Terman: 'Genius and Stupidity.'

Charles W. Waddle: 'Miracles of Healing.'

Roy Titus Wells: 'Experiments on the Self-Induction of Currents in Cylindrical Cores.'

NEW YORK UNIVERSITY.

Frederick Malling Pedersen: 'The Influence of Molecular Constitution upon the Internal Friction of Gases.'

UNIVERSITY OF WISCONSIN.

Edgar Burton Hutchins: 'A Contribution to the Chemistry of the Tellurates.'

Oliver Patterson Watts: 'An Investigation of the Borides and the Silicides.'

Stephen Marshall Hadley: 'Relative Masses of Binary Stars.'

GEORGE WASHINGTON UNIVERSITY.

Ray Smith Bassler: 'A Study of the James Types of Ordovician and Silurian Bryozoa.'

Hiram Colver McNeil: 'On the Constitution of Certain Natural Silicates.'

Henry Albert Pressey: 'Flow of Water in Channels.'

UNIVERSITY OF MINNESOTA.

Edward M. Freeman: 'The Seed-Fungus of *Lolium Temulentum* L., the Darnel.'

UNIVERSITY OF CALIFORNIA.

Ralph Hamilton Curtiss: I., 'A Method of Measurement and Reduction of Spectrograms for the Determination of Radial Velocities.' II., 'Application to a Study of the Variable Star W Sagittarii.'

Charles Gardner Rogers: 'The Effect of Various Salts upon the Survival of the Invertebrate Heart.'

Mooshegh Vaygouny: 'On Two New Electrochemical Processes for the Extraction of Silver and Gold from their Ores.'

BROWN UNIVERSITY.

Norman Armin Dubois: 'Some Condensation Products of 1-Phenyl-Naphthalene 2, 3, Dicarboxylic-Anhydride.'

Arthur Eugene Watson: 'An Investigation into the Source of the Condensation-Nuclei produced by the Action of X-Rays in Dust-Free Air.'

PRINCETON UNIVERSITY.

Adam Miller Hiltebeitel: 'The Problem of Two Fixed Centers and Certain of its Generalizations.'

Walter Mann Mitchell: 'Researches in the Sun-Spot Spectrum, Region F–A.'

Frank Albert Stromsten: 'Contributions to the Anatomy and Development of the Venous System of Turtles.'

LELAND STANFORD JUNIOR UNIVERSITY.

William Albert Manning: 'Studies on the Class of Primitive Substitution Groups.'

UNIVERSITY OF NEBRASKA.

Esther Pearl Hensel: 'An Investigation of the Movements of Petals.'

Homer Leroy Shantz: 'A Study of the Vegetation of the Mesa Region East of Pike's Peak.'

STATE UNIVERSITY OF IOWA.

Paul Bartsch: 'A Study in Distribution Based upon the Family Pyramidellidæ of the West Coast of America.'

William Bonar Bell: 'Modifications in Size, Form and Function of Homologous Crustacean Appendages.'

UNIVERSITY OF CINCINNATI.

Harry Shipley Fry: 'The Reducing of Magnesium Amalgam on Aromatic Nitro Compounds.'

UNIVERSITY OF MISSOURI.

Francis Potter Daniels: 'The Flora of Columbia, Missouri and Vicinity. An Ecological and Systematic Study of a Local Flora.'

THE ADVANCE OF OUR KNOWLEDGE OF THE CAUSATION AND METHODS OF PREVENTION OF STOCK DISEASES IN SOUTH AFRICA DURING THE LAST TEN YEARS.

II.

B. PARASITE UNKNOWN.

I. *Rinderpest.*

We now turn our attention to the important diseases of the second group. In these the parasites causing them are unknown—that is to say, no parasites can be detected by the microscope or by culture—but it is equally true that they must be present in the blood and fluids of the sick animals in some form or other. In all probability they are ultra-microscopic—too small to be seen with our present instruments. This is borne out by the fact that they are able to pass through the pores of porcelain filters, which keep back the smallest micro-organisms we are able to recognize.

The first of the second group of diseases is rinderpest, which has overrun and devastated South Africa within the last ten years.

Rinderpest has been known from time immemorial in Europe and Central Asia, and is an exceedingly fatal disease, killing 90 to 100 per cent. of the cattle attacked.

The recent epidemic, according to some, originated in the Nile provinces, and slowly crept southwards, reaching the Transvaal in 1896, after a journey lasting some fifteen years. Great efforts were made to oppose its passage, but nothing seemed to avail. In parts of the country where there were few or no cattle the epidemic spread by means of the wild animals—particularly the buffalo—which have been exterminated in many places.

Ten years ago the symptoms and contagious nature of this disease were well known, but nothing was known as to methods of prevention, and it is to the investigation of this epidemic in South Africa that the discovery of practical methods of immunizing cattle, and in this way of stamping out the disease, is due.

As soon as it was apparent that the epidemic was spreading into South Africa, all the colonies made strenuous efforts to combat it. The Transvaal government invoked the aid of the Pasteur Institute, and Messrs. Bordet and Danysz were sent out to discover some method of prevention. They worked near Pretoria, and were assisted by Dr. Theiler, then the principal veterinary surgeon. Before they arrived on the scene the Natal government had despatched Mr. Watkins-Pitchford, their principal veterinary surgeon, to the Transvaal, where he also at first had Dr. Theiler as his colleague, and where he did some good pioneer work in the serum therapeutics of the disease. In the Cape Colony Dr. Hutcheon, the principal veterinary surgeon, and Dr. Edington, the government bacteriologist, were no less active. It is, however, to Professor Robert Koch, of Berlin, that the honor is undoubtedly due of first publishing a practical method of immunizing cattle against rinderpest. He arrived at Kimberley on December 5, 1896, and in the incredibly short space of time of two months was able to report two methods of immunizing, viz., by the injection of rinderpest bile, and, secondly, by the injection of serum from immune animals. I have always thought that the discovery that the injection of bile taken from an animal dead of rinderpest rendered cattle immune was particularly brilliant. Up to that time no one had dreamt that bile could possess such a quality. It is true that both Transvaal and Orange Free State Boers are said to have

used a mixture of bile and blood from dead animals before Koch's researches, and also that Semmer in 1893 showed that serum might be used for protective purposes; but still to Koch is due the credit of making these processes practical. After he left South Africa his work was continued by Kolle and Turner, who greatly improved the methods; and it is to them, and to the other workers mentioned above, that we owe the fact that rinderpest has now lost its terrors.

In the last recrudescence of this disease in the Transvaal, in 1904, Mr. Stewart Stockman, the principal veterinary surgeon, and Dr. Theiler, thanks to the experience and knowledge gained during the last ten years, were enabled to stamp out the disease rapidly and completely. It is to them also that we owe our knowledge of the dangers of the intensive method of inoculation, much used in the past and due to Kolle and Turner, and the introduction of the fighting against the plague by the inoculation of the healthy cattle by injections of immune serum alone.

In the tsetse-fly disease our advance in knowledge has been in regard to the causation of the disease, and not in its prevention; it is quite otherwise with rinderpest. The contagium or cause of rinderpest is absolutely unknown. We know it exists in the blood, nasal, mucous and other secretions of the sick animal, as all these are infective, but no one has seen it. The smallest quantity of blood will give the disease if injected under the skin of a healthy animal. We also know that the contagium is not very resistant. Blood soon loses its virulence after it leaves the body, and the effect of drying or the addition of chemical preservatives, such as glycerine, acts also injuriously to the contagium, whatever it may be. It evidently belongs to the ultra-visible sort of micro-organisms, as it is said to pass through a porcelain filter.

How the contagium passes from the sick to the healthy is assumed to be by contact. No experiments have, as far as I am aware, been made as to whether it is conveyed by insects as well; but, as Professor John MacFadyean says, as it spreads in all countries and climates and seasons, and the contagium is easily carried on the persons or clothes of human beings, it is improbable that insects have anything to do with it.

It is in the methods of protective inoculation that the great advance has been made in our knowledge of this disease. Ten years ago no means were available to stay the progress of this plague; now it has lost its terrors. As soon as it appears it can be immediately attacked and stamped out. This is done by rendering the surrounding cattle immune to the disease by injecting immune serum. This serum is prepared by taking immune cattle and hyper-immunizing them by the injection of large quantities of virulent blood, so as to make their blood serum as anti-toxic as possible. If there are no immune cattle at hand, cattle can be immunized by Koch's bile injection method and then hyper-immunized; but, of course, in practise—for example, here in the Transvaal—large quantities of immune serum are kept ready for emergencies, and a herd of immune cattle kept up for the supply of the serum. This satisfactory state of affairs, as far as this disease is concerned, is, of course, the outcome of an immense amount of thought and experiment, and I have already mentioned the chief scientific men to whom this country owes this great boon.

Different methods of immunizing have been tried during these years. Up to 1903 the prevailing custom was to use what was known as the virulent-blood and serum method. That is to say, immune serum and virulent blood were injected at the same time, in order that the animal might pass through a modified attack of the dis-

ease. Since 1903, however, in the Transvaal this method has been stopped, and the 'serum alone' method introduced. This method is based on the fact that the virus of rinderpest does not retain its infective property outside the body for more than a day or two; that it dies out in the animal, as a rule, in fourteen days, but in chronic cases only after thirty days, and that, therefore, the healthy cattle in an affected herd must be protected for this length of time. Now 'serum alone' only protects for about ten days, and therefore the cattle must be inoculated three times at intervals of ten days. The doses of serum must also be large—from 50 c.c. to 200 c.c.—so that this method of stamping out rinderpest, although quite efficacious, entails a good deal of labor. It is necessary, then, to spare no expense in making the Veterinary Department efficient, and any cheese-paring legislation in this direction may be disastrous.

II. *Horse-sickness.*

The next stock plague I would bring before your notice is horse-sickness. This is a disease which only affects equines—the horse, mule and rarely the donkey. It is a very fatal disease, carrying off thousands of horses every year. It is one of the most important diseases in South Africa, and, if it could be coped with, would enable the Transvaal to become one of the best horse-breeding countries in the world. At present it is dangerous for any one in Natal and many parts of the Transvaal to possess a valuable horse, the chances of losing it by horse-sickness being so great.

In 1895, when I went to the north of Zululand with the Ingwavuma expedition, we lost all our horses with this disease. We started with a hundred horses, and had to march back on foot, every horse having died.

Ten years ago, when I arrived in South Africa, our knowledge of this disease was confined to the disease itself; nothing was known as to its causation or prevention. Credit is due to Dr. Edington for having accurately described the lesions and shown its ready inoculability, period of incubation, etc. He, however, fell into the mistake of attributing its causation to a species of mold fungus.

Etiology: Geographical Distribution.—Horse-sickness is widely distributed throughout Africa. It is common in Natal, Zululand, the greater part of the Transvaal, Rhodesia, Bechuanaland and Portuguese East Africa. In Cape Colony it occurs in epidemics, with intervals of ten to twenty years. It is undoubtedly a disease which prevails chiefly *in low-lying localities* and valleys, and is but rarely met with in elevated exposed positions. It, however, is met with now and then in river valleys up to an elevation of some thousands of feet. *Season* has also a remarkable influence on its development, being exceedingly common in summer and disappearing on the appearance of the first frosts of winter.

Ten years ago various theories were held as to the cause of this disease. Some people thought that it was due to eating poisonous herbs; others, to some peculiarity or state of the night atmosphere; others, to eating grass covered with dew; and still others, to the eating of the spiders' webs which may be seen on the grass in the morning. It was known at that time not to be contagious in the ordinary sense of that term; that is to say, a horse could be stabled alongside a case of horse-sickness without incurring the disease, or a horse might be placed without danger in the same stall in which a horse had recently died of horse-sickness.

Nature of the Disease.—A horse which has been exposed to infection shows no signs of the disease for about a week. Its

temperature then goes up rapidly, and it dies after four or five days' illness. Very often the horse appears perfectly well until within a few hours of death. For example, my horse was the last one to die on the Ingwavuma expedition. On the day of his death I rode him until noon without noticing anything amiss. He then became rather dull in his movements, and I handed him over to the groom to lead. He died that evening immediately after we got into camp. It is, therefore, a very rapidly fatal disease, and almost every horse which is attacked by it succumbs. I have never seen a case of horse-sickness which had been brought on by artificial inoculation recover. But there can be no doubt that a small percentage of horses infected naturally do recover, and these recovered horses are, more or less, immune in future to the disease. There is no necessity for me to describe the symptoms of this well-known disease, as every one who has to do with horses in South Africa is perfectly familiar with it, and every one has seen dead horses with the characteristic mass of white foam issuing from their nostrils, due to the effusion of the liquid part of the blood into the lungs and trachea.

Nature of the Virus which causes this Disease.—There can be no doubt that this disease, like the tsetse-fly disease, is caused by some form of blood parasite. A small quantity of fluid taken from any part of a horse suffering from horse-sickness is capable of giving rise to the disease if injected under the skin of a healthy horse. For example, the thousandth part of a drop of blood from a sick horse will, in many cases, give rise to the disease if injected under the skin of a healthy horse. It must be admitted, however, that some horses require a larger dose than others, but it may be said that no horse has yet been found to withstand more than a comparatively small quantity of infective blood thrown under the skin. Now, although every drop of blood must contain many of the organisms of this disease, yet the most careful examination of such blood under the highest powers of the microscope reveals nothing. Again, if we filter horse-sickness blood through a porcelain filter—a filter which is capable of keeping back all the known visible micro-organisms—the filtrate is found to be virulent. It is evident, then, that we are here dealing with a blood parasite so small in size as to be absolutely invisible to the highest powers of the microscope, and also so minute as to readily pass through the pores of a Chamberlain filter. What the nature of this parasite is one can not tell. It behaves in many curious ways. For example, horse-sickness blood which is simply dried and pounded into powder is found to be perfectly inert. On the other hand, blood kept in the moist condition remains virulent and capable of giving rise to the disease for years. Or, again, the germ of horse-sickness is so resistant to external agencies that if, as described by MacFadyean, a part of the liver of a horse dead from horse-sickness be buried in the ground and subjected to putrefaction, it is found that the liver tissue retains its infectivity for months. Although a very small quantity of blood introduced under the skin of a horse will almost certainly give rise to the disease, it is quite different if the blood is introduced into the stomach. In the latter case a small quantity of blood has no effect, and the horse requires to be drenched with a pint or more before the disease can be given in this way.

The question now arises as to how horses are infected by this disease in nature. On account of the small quantity of blood which will give rise to the disease if injected under the skin, and the large quantity required before the disease can be con-

veyed through the stomach, for a long time it has been supposed that it must be conveyed from sick to healthy horses by means of some biting insect. Experiments have been made within the last few years by Watkins-Pitchford and others in order to clear up this aspect of the question. Horses have been placed in fly-proof shelters in exceedingly unhealthy places, and it was found that in no case did any of these protected horses incur the disease; whereas horses allowed to feed in the same place, but without any shelter, soon succumbed to the disease. But, up to the present, as far as I am aware, the particular biting fly, mosquito or other insect which is the carrier of this disease has not been discovered, and there can be no doubt that one of the most important facts to make out in the etiology of this disease is the discovery of the particular insect which conveys the disease from the sick to the healthy. By this discovery a flood of light may be thrown on the causation of the disease, and some means discovered of combating the disease through the insect, as has been successful in some instances in regard to the case of human malaria.

Professor MacFadyean also suggests that experiments are needed to show what is the 'reservoir' of the virus.

Prevention.—Although we have been unfortunate up to the present in not being able to make out the exact nature of the parasitic cause of this disease, or to discover the exact insect which carries it, a large amount of patient, persevering work has been done within the last ten years in regard to its prevention by protective inoculation.

In this important work Bordet, Edington, Koch, Theiler, Watkins-Pitchford and others have labored for many years, and, according to recent reports, with some measure of success.

Dr. Edington, for example, who has been working at this problem for several years, reports that heart-water is identical with horse-sickness, and that by inoculating mules with heart-water blood he has been able to salt them against horse-sickness. He says that experiments testing this vaccine show it to be an ideal one. It gives a high protection to the animals inoculated. Its keeping powers are excellent. No animal has died as the result of this inoculation, nor has any dangerous symptom been produced. He states that he is not in a position to supply a vaccine for horse-sickness in horses, but has every hope of attaining this successful end very shortly.

We must congratulate Dr. Edington on his results, and trust that this method of conferring immunity may prove itself to be successful when put to practical use. For my part, I am somewhat sceptical of Dr. Edington's methods of immunizing against horse-sickness. I am sure he will forgive my expression of scepticism when I recall to his memory the various methods he has already brought forward, just as optimistically, and which have all been tried and found wanting.

Dr. Koch has lately recommended a method of immunization against horse-sickness. This is the artificial establishment of an active immunity in susceptible animals by gradually increased doses of virulent blood, alternated in the early stages of treatment with the injection of serum prepared from the blood of highly fortified salted horses. Mr. Gray reports that the experiments already conducted on these lines show that the process as laid down by Koch requires important modification before the process of establishing immunity against horse-sickness can be of any practical use.

Mr. Watkins-Pitchford in Natal is also hopeful of succeeding in producing immunity against horse-sickness.

Dr. Theiler, too, reports that he has succeeded in producing a serum which can be utilized in connection with virulent blood to confer active immunity. He informs me that his method is a subcutaneous injection of serum and an intra-jugular injection of virus carried out simultaneously. The death rate in mules, from the effect of the inoculation, he states to be about five per cent. It is higher in horses, but he expects shortly to attain the same result in them. During the last horse-sickness season he exposed 200 immunized mules to natural infection in various parts of the country. Of that number only one died with symptoms of horse-sickness. As Dr. Theiler is himself communicating his method in detail to the association, I need not enter more fully into it.

The man who discovers a practical method of dealing with horse-sickness will be one of the greatest benefactors of this country. There has always been a tradition that a large money reward is awaiting this discovery. I do not know whether this is well founded or not, but certainly such a work would well deserve the highest possible reward. The best reward is to give the successful investigator more opportunity and more assistance in pursuing his beneficent work. The reward given by the French people to Pasteur was the Pasteur Institute; by the German government to Koch, the Imperial Hygienic Institution.

Catarrhal Fever of Sheep: Blue Tongue.—This disease was first described by Hutcheon, the chief veterinary surgeon of Cape Colony.[2] It is very similar in many respects to horse-sickness. Both these diseases occur most often in low-lying, damp situations, such as river valleys and the coast plain. They also occur at the same time of the year; that is, from January to April. Blue tongue, like horse-sickness, is probably carried from the sick to the healthy by means of some night-feeding insect. At the same time the diseases are not identical, since the inoculation of horse-sickness blood into a sheep does not give rise to blue tongue, nor the blood of the sheep injected into the horse give rise to horse-sickness.

To Mr. Spreuill, government veterinary surgeon in Cape Colony, acting under the advice of Hutcheon, is due the credit of proving that a preventive serum could be prepared capable of immunizing sheep against this disease. Dr. Theiler informs me he has repeated Mr. Spreuill's experiments, and they hope to introduce this method of inoculation at an early date.

Heart-water of Cattle, Goats and Sheep.—This disease was also first clearly described by Mr. Hutcheon. It occurs in the Transvaal, Natal and Cape Colony, and is responsible for much of the yearly loss among the cattle, sheep and goats.

Like the last disease—blue tongue—it resembles horse-sickness in many ways, and, in fact, has been described by Dr. Edington as being identical with it. Like horse-sickness, it is a blood disease with an invisible parasite, so that blood injected under the skin of susceptible animals gives rise to the disease. One difference between the parasites of the two diseases is, that whereas that of horse-sickness is contained in the fluid of the blood, that of heart-water is probably restricted to the red blood corpuscles. The serum separated from the blood is incapable of giving rise to the disease, and the straw-colored pericardial fluid, when injected into susceptible ani-

[2] It is to Mr. Hutcheon that South Africa owes its knowledge of many stock diseases. For the last twenty-five years he has labored with the utmost earnestness in Cape Colony, often under trying conditions, and his description of the various diseases formed the basis of all the modern work done on the subject.

mals, fails to give rise to any symptoms of the disease. Horse-sickness blood filtered through a porcelain filter is still infective; the opposite holds good up to the present with heart-water. Horse-sickness blood can be kept for years without losing its virulence; heart-water blood loses it in forty-eight hours.

Heart-water has a peculiar distribution, being restricted to the certain tracts of country with a warm, moist climate. It is known to farmers that if they remove their flocks to the high veld the disease dies out.

To Lounsbury is due the credit of explaining these facts. He found that the disease is carried from sick to healthy animals by means of the bont tick, *Amblyomma hebræum.* This tick leaves its host between each molting, and a larva which sucks the blood of an infected animal is capable of giving rise to the disease in a susceptible animal as either a nympha or imago. The distribution of this tick corresponds to the distribution of the disease. If this tick could be killed off, the disease would disappear from the country. This could doubtless be done on individual farms by long-continued dipping; but in the meantime some method of immunization might be devised.

D. Bruce.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

SUMMER MEETING OF SECTION C. GEOLOGY AND GEOGRAPHY.

The section of geology and geography (Section E) of the American Association for the Advancement of Science held a summer field meeting at and near Syracuse, N. Y., July 19 to 22, inclusive, in conjunction with the intercollegiate summer courses in geology. Although the attendance was not large, it was fairly satisfactory, and as many participated in the daily excursions as could be cared for conveniently on foot. The heat of the early part of the week moderated somewhat by Thursday, the first field day of the meeting, and good weather prevailed during the sessions.

The opening session was held on Wednesday evening in the chapel of the College of Liberal Arts of Syracuse University, and was called to order by the secretary of the section, who introduced as chairman of the meeting Professor William North Rice, of Middletown, Conn., in place of Professor E. A. Smith, of University, Ala., chairman of the section and vice-president of the association for 1905, who was absent on account of his duties as state geologist of Alabama. Addresses of welcome were delivered by Mayor Alan C. Fobes in behalf of the city of Syracuse, by Dean Frank C. Smalley in behalf of Syracuse University and by Dr. John van Duyn in behalf of the University Club. After a felicitous reply by the chairman, Professor T. C. Hopkins, of Syracuse University, briefly outlined the program of work and excursions for the succeeding days and gave a concise sketch of the geology of the vicinity of Syracuse.

On Thursday the members and others in attendance divided for convenience into two parties, one of which, under the guidance of Professor Hopkins, devoted its attention during the morning to problems of stratigraphy near Jamesville, southeast of Syracuse, while the other, under the leadership of Professor H. L. Fairchild, of Rochester, studied the great Railroad Channel and other river channels formed during the recession from central New York state of the ice of the glacial epoch. The two parties met about noon at Green Lake near Jamesville and, after luncheon, listened to an exposition of 'The Local Glacial Features,' by Professor Fairchild. The most striking of these features are the drumlins, which have long been familiar to

geologists, and the marginal stream channels and 'fossil waterfalls,' the details of which have been developed and described by Fairchild and others. Green Lake, or, as it has been rechristened, Jamesville Lake, is a pretty pond without surface outlet lying in a gorge at the base of a hundred-and-fifty-foot cliff over which in glacial times there must have poured a waterfall comparable in height and volume to the present Horseshoe Fall at Niagara.

Professor Hopkins then gave a paper on the 'Stratigraphic and Economic Geology of the Syracuse Region.' The greater part of the city is located on outcrops of Salina (Silurian) shales. North of the city there occur within a few miles outcrops of the Niagara limestones and shales, the Clinton limestones and shales and the Medina sandstone. In going southward from the city one traverses the upper divisions of the Silurian and the Devonian. In the near vicinity of Syracuse are the type localities of several important groups. The chief economic geologic products of the vicinity of Syracuse are common salt, gypsum and limestone.

In the afternoon the combined parties traversed the great glacial river channel lying southwest of Jamesville and extending from Butternut Creek on the east to the upper slopes of the valley of Onondaga Creek on the west. The evening was devoted to a public illustrated lecture by Professor Fairchild on 'Glaciation in North America, with Particular Reference to the Effects of the Ice Sheet in Central New York.' The lecture was complimentary to the citizens of Syracuse, and an audience of about one hundred and fifty persons greeted the speaker in Assembly Hall, University Block. After the lecture there was an informal social meeting of the section in the rooms of the University Club.

On Friday the excursionists, under the leadership of Professors Fairchild and Hopkins, visited the important gypsum quarries and the great glacial stream channels and 'fossil waterfalls' southwest of and near Fayetteville, about eight miles east of Syracuse. The noon hour was passed beside Blue Lake, at the base of a cliff marking an ancient Horseshoe Fall, and the time was improved by listening to an address by Mr. Frank B. Taylor, of Fort Wayne, Ind., on 'The Great Lakes in Their Relation to Local Geology.' Mr. Taylor showed by means of maps the extent of some of the great glacial lakes affecting the region and gave some of the results of recent studies by himself and others in the vicinity of Lake Huron.

Friday evening was utilized for a regular meeting of the section, in the rooms of the University Club, for the reading of papers. A list of the speakers with abstracts of their papers follows:

F. P. Gulliver on 'Sudbury Basin Shorelines.' The author described the shore lines of Reservoir No. 5, of the Metropolitan System of reservoirs for Greater Boston, situated in the Sudbury Basin and largely in the towns of Marlboro and Southboro, Mass. Use was made of these shore lines for field work with the classes of the author at St. Mark's School, Southboro. The water in this reservoir has a successive series of changes of level from the high water of early spring to the low water of fall, and, therefore, the shores, which are largely composed of gravel, record the features of shore lines of elevation. At points where the water remains at the same level for the longest time the cliffs and beaches and other shore-line features are more strongly developed, and where the water was at a given level for a very short time the features are correspondingly faint. Bay-bars are formed at some points, spits at others, tomboles behind boulders, ripple marks on the bottom, sorting of fine and coarse material; in fact, nearly all the fea-

tures which are seen along most natural shore lines are here well represented. The paper was illustrated by means of photographs of various typical shore-line forms which were taken by the boys in the author's classes.

H. L. Fairchild on 'Some New Problems in Glaciology.' The author described by the aid of a large scale map some high-level glacial channels recently recognized by him in the Split Rock region southwest of Syracuse. These channels are at a greater altitude than the large and well-marked channels and waterfalls farther south which were included in the field studies of the meeting. The problem of the conditions of their formation has not yet been solved.

A. W. Grabau on 'The Physical Character and History of Some New York Formations.' This address was prepared for delivery in the field on Saturday, but it was deemed best to hear it at the meeting of Friday evening. The author briefly reviewed the New York series of sedimentary rocks and its nomenclature and described some of the difficulties in correlation which have been brought to light by recent detailed field studies.

C. J. Sarle on 'The Burrow Origin of *Arthrophycus* and *Dædalus* (*Vexillum*).' The author's conclusions regarding the problematic genera *Arthrophycus* Hall and *Dædalus* (Rouault) have been reached through a study of *Arthrophycus alleghaniensis* (Harlan) and *Dædalus archimedes* (Ringueberg) as they occur in the Medina formation. One form of *D. archimedes* from the Medina is known as *Spirophyton archimedes* Ringueberg. In Europe the genus is known as *Vexillum* (Rouault). The author holds that *Dædalus* has always been described in an inverted position, that the ridges by which *Arthrophycus* is known are only the bases of a fossil having a compound structure very similar to that of *Dædalus*, and that both are the result of the repeated shiftings of burrows, probably of worms. The paper was illustrated by means of diagrams and some remarkably fine specimens.

David White on 'The Occurrence of Glacial Epochs in Paleozoic Time.' In this paper the author concisely stated the evidences from plant life and other phenomena in favor of the theory that there was extensive glaciation in Carboniferous time, particularly in portions of the southern hemisphere.

David White on 'The Age of the Wise and Harlan Formations of Southwestern Virginia.' The Wise and Harlan formations, 1,270 and 880 feet, respectively, in thickness, embrace the youngest Paleozoic (Coal Measures) rocks in the Estillville and Bristol quadrangles of the Virginia-Kentucky region. As originally proposed by Campbell, the Wise, consisting of a heterogeneous mass of sandstones and shales with coals, and the overlying Harlan, similarly constituted but somewhat more arenaceous near its base, were tentatively paralleled with the Monongahela and Dunkard formations in western Pennsylvania. Since then the basal portion of the Wise has been referred by Stevenson, on stratigraphic grounds, to the upper Pottsville, while the writer provisionally included the whole of the Wise in the Pottsville.

Fossil plants more recently gathered not only confirm this reference of the entire Wise, but show the lower portion of the Harlan also to antedate the Allegheny of the northern bituminous region. The plants from the roof of the High (Big) Splint coal near the top of Big Black Mountain are Kanawha (Pottsville) in age, as are also those from a horizon 150 feet higher, in the Harlan. Additional fossil material will be required before it will be possible to conclude with certainty whether the coals four to five hundred feet above the

High Splint are younger than the Stockton coal, the top of the Kanawha, which the writer places, together with the Black Flint, within the Pottsville, and which at highest can not be later than the Brookville coal (base of the Allegheny), where it is now placed by Stevenson.

The further progress in the study of the fossil floras brings support to the writer's rough provisional correlation of the Harlan formation with the Anderson in Tennessee, and in part with the Charleston sandstone in West Virginia, though the lower boundaries are probably earlier in the more southern formations. The enormous expansion already noted in the southward extension of the Sewell and lower Kanawha is apparently shared by the upper Kanawha and Homewood stages in the southern Appalachian coal field.

E. O. Hovey on 'The Western Sierra Madre of the State of Chihauhua, Mexico.' The paper described very briefly some of the geologic and geographic features of the country traversed by the author in company with Professor Robert T. Hill, on a journey by pack train from Nuevas Casas Grandes southward to Ocampo (Jesus Maria) and thence northeastward to Miñaca. The great plateau of Mexico, in Chihuahua at least, has been built up on a foundation of Cretaceous limestone and schist and post-Cretaceous granite by countless volcanic eruptions of lava streams and tuff beds. The constructional surface thus produced has been leveled by atmospheric action and sheetflood erosion, and the great cañons have subsequently been cut in the elevated plateau. The Navosaigame formation of ancient local conglomerate was described and named.

On Saturday the members and others in attendance upon the meeting again divided into two sections, one under the guidance of Professor Hopkins and the other under that of Professor Fairchild. The former continued stratigraphic and economic studies near Fayetteville, while the latter went southwestward to the Split Rock quarries of the Solvay Process Co. in the heavy-bedded Onondaga limestone about five miles from the city. From near Split Rock can be seen some of the high-level ancient channels which have suggested to Professor Fairchild his new problems in glaciology. A section of the Split Rock party continued its excursion to Skaneateles Lake and returned through the Marcellus-Cedarvale glacial channel and the Onondaga valley to the city. Other places of interest visited by members were the serpentine dike in the northeastern part of the city and the extensive salt works.

Before adjournment the section passed a hearty vote of thanks to the City of Syracuse, Syracuse University, the University Club, the Citizens Club and the City Library Association, and expressed its appreciation of the labor in behalf of the meeting expended by Professors Hopkins and Fairchild. About fifty persons, half of whom were members or prospective members, attended the various excursions and sessions, aside from the number in attendance upon the public lecture.

EDMUND OTIS HOVEY,
Secretary.

SCIENTIFIC BOOKS.

Die Lichtsinnesorgane der Laubblätter. By G. HABERLANDT. Leipzig, Wilhelm Engelmann. 1905. Pp. 142, pl. 4.

In this work, Haberlandt has brought together the results of his extensive studies of the perception of light by the leaf, some of which have already appeared in his 'Physiologische Pflanzenanatomie' and in various papers. The book is one of great interest and it should be read by every botanist concerned with the relation of plants to stimuli. A critical reading, however, is very necessary, since the text contains much special pleading. The author rejects Sachs's view that heliotropic

stimulation is due to the direction of the rays of light, and not to differences of light intensity. In its place he advances the hypothesis that the direction of the light can act but indirectly by producing differences of intensity. In support of this view, it is assumed that the perception of light stimuli is localized in the upper epidermis, and that the arched epidermal cells of *Ficus, Hedera, Magnolia, Oxalis,* etc., and the so-called ocelli of *Fittonia, Impatiens* and *Peperomia* serve as definite sense organs for perceiving light. The author proves experimentally by photographic prints of the epidermis that these sense-organs concentrate the light upon or near the cytoplasm of the inner epidermal wall. Further than this, his exposition, as he himself states, 'oftentimes possesses a purely hypothetical character.' The facts gained by the author's experiments are a valuable addition to our knowledge of the intimate details of the reception of light by the leaf. As a whole, however, the book contains far too much speculation, and is too much pervaded by an obvious bias in favor of 'sense-organs.' It is an excellent example of first-class experimental work marred by unscientific treatment of the results obtained.

FREDERIC E. CLEMENTS.

THE UNIVERSITY OF NEBRASKA.

Soil Bacteria and Nitrogen Assimilation. By FREDERICK D. CHESTER. Bulletin 66 (Nov., 1904), Delaware College Agricultural Experiment Station, Newark, Del.

In a bulletin bearing the above title Frederick D. Chester records his experiments with free nitrogen-assimilating bacteria. He states that nitrogen-fixing bacteria are present in all soils. Some fix nitrogen more actively than others. These microbes are stimulated to greater activity by free soil tillage, due to the fact that they are essentially aerobic and frequent stirring up of the soil supplies them with the necessary oxygen (air). Since these low organisms further require organic matter and lime for their food, he advises the liberal supply of these articles to the soil in order that the organisms may multiply rapidly and fix the free nitrogen of the air more actively for the use of higher plants. The more technical side of the paper deals with the methods of technique and the culture characteristics of the microbes described. The first part of the paper is historical, reviewing largely the European work along similar lines. It is an exceedingly interesting paper and the reader is advised to consult the original.

ALBERT SCHNEIDER.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for August contains the following papers: 'A Systematic Study of the Saliaceæ,' by D. P. Penhallow, containing, among other conclusions, that the Saliaceæ as a whole is an old world family with a strong tendency to a boreal habitat, and the present tropical and subtropical members of the group probably represent the relics of a wider distribution in Cretaceous and Tertiary time. 'Developmental Stages in the Lagenidæ,' by J. A. Cushman. The writer considers that Hyatt's laws of development may be applied to the Foraminifera and that where young individuals can be obtained their relations are usually made out with ease. B. M. Davis gives the seventh of the series of 'Studies on the Plant Cell,' accompanied by a bibliography of papers referred to in section V.

The Popular Science Monthly for September has the following articles:

CHARLES KEYSER EDMUNDS: 'China's Renaissance.'

FRANK LINCOLN STEVENS: 'The Science of Plant Pathology.'

J. MADISON TAYLOR: 'Sleep and its Regulation.'

C. W. FOULK and R. F. EARHART: 'State University Salaries.'

EDWIN RAY LANKESTER: 'Nature and Man.'

CHAS. D. MARX: 'General Education for Engineers.'

DUDLEY F. SICHER: 'Quackery.'

LAWRENCE J. BURPEE: 'How Canada is solving her Transportation Problem.'

EDWARD J. BERRY: 'The Ancestors of the Big Trees (Sequoias).'

SOCIETIES AND ACADEMIES.

RECENT FOLK-LORE MEETINGS IN CALIFORNIA.

THE first regular meeting of the Berkeley Folk-Lore Club, founded May 3, 1905, was

held on the evening of August 18 at the University of California.

The committee appointed to draft an organization reported as follows:

REPORT OF THE COMMITTEE.

The committee appointed May 3, 1905, by unanimous vote of the charter members of the Berkeley Folk-Lore Club to report on a scheme of organization for the club, beg leave to submit the following:

CONSTITUTION OF THE BERKELEY FOLK-LORE CLUB.

1. This society shall be called the Berkeley Folk-Lore Club.

2. Besides the fifteen charter members, to wit: Messrs. Lange, Mitchell, Goddard, Dresslar, Hart, Setchell, Merriam, Richardson, Fryer, Gayley, Miller, Ritter, Keeler, Noyes and Kroeber, members shall consist of such men members of the academic senate of the University of California, and such men members in good standing of the American Folk-Lore Society, as are unanimously elected by the club; and of such only.

3. The officers shall be a president, vice-president and secretary, who shall constitute an executive committee which shall arrange for all meetings and transact all business of the club.

4. Four or more meetings annually shall be held, at the first of which in each academic year the officers shall be elected.

5. Five shall constitute a quorum for the transaction of business.

6. Amendments to this constitution may be proposed at any meeting of the club and adopted by a two thirds vote of those present at the next meeting.

The committee recommend the adoption of this constitution and the immediate organization of the club under its provisions.

Signed: A. L. Kroeber,
Charles Keeler,
G. R. Noyes.

The report of the committee was discussed and accepted, the proposed constitution being thereby adopted.

The following officers were then elected:

President—A. F. Lange.
Vice-President—Charles Keeler.
Secretary—A. L. Kroeber.

New members elected were: Professor F. W. Putnam, Dr. B. P. Kurtz and Professor H. K. Schilling.

The committee on the establishment of a California branch of the American Folk-Lore Society reported as follows:

REPORT OF THE COMMITTEE.

The committee appointed May 3, 1905, on vote of the charter members of the Berkeley Folk-Lore Club to report on the feasibility of the establishment of a California branch of the American Folk-Lore Society beg leave to submit the following recommendations:

That the formation of the Berkeley Folk-Lore Club provides an opportune basis for the establishment and successful development of a California branch of the American Folk-Lore Society, which will extend the work undertaken by the Berkeley Folk-Lore Club to a wider sphere of influence and bring it before a larger body of persons, thus enhancing the promotion of folk-lore interests on the Pacific coast. Be it resolved, therefore,

That a California branch of the American Folk-Lore Society be hereby organized by such of those present as signify their willingness; and

That a committee of five be appointed to arrange for a meeting, including a program, in Berkeley, on the evening of August 28; said committee to submit at this meeting a formal draft of organization, with nominations for officers, for the California branch of the American Folk-Lore Society.

Signed: A. L. Kroeber,
Charles Keeler,
G. R. Noyes.

This report was adopted, and the following committee appointed under its provisions to report at the first meeting of the California branch on August 28: J. C. Merriam, G. R. Noyes, A. L. Kroeber, W. C. Mitchell and Charles Keeler.

DISCUSSION AND CORRESPONDENCE.

LATIN AS THE LANGUAGE OF BOTANICAL DIAGNOSIS.

Among the resolutions passed by a majority vote at the recent congress of botanists at Vienna, one only seems to have altogether surprised us in America, and that is the one the import of which is conveyed in the above caption. A large number of botanists—a list of names embracing very many of the leading systematic botanists of Europe—have announced that after two years more new genera

and new species of plants will not, with them, obtain recognition as published, unless the diagnoses of them be in Latin.

This ruling of the Vienna congress has quite startled the botanical public on our side of the Atlantic, if one may judge by the comments one hears; and the present writer, being one who has published many new generic propositions, and an exceedingly long list of species, all in English—and next to none at all in Latin—has already been asked repeatedly for his opinion as to this regulation.

Now as to the fact of its having come to us as a surprise, I think that our twentieth-century generation botanist is the only one to whom such a resolution would have come as a surprise. Anyhow, all of us who are familiar with the work of the great American botanists of the last half of the nineteenth century know that with them—Torrey, Engelmann, Gray, Tuckermann and several lesser names—the descriptions of their new genera and species were published in Latin; the only exceptional instances being those of their coming upon new types in the course of the publication of books and manuals intended primarily for the use of an English-speaking public, and in which only a few of the genera and species were new. And if we go back to still earlier generations we find that even the whole flora of North America, when done in book form, was done in Latin, as to the essential characters of all the genera and all the species, both old and new. Need one name Walter's 'Flora Caroliniana,' Michaux's, Pursh's and Hooker's immortal classics on the botany of an English-speaking land?

And the reason is readily manifest. Latin is, and has always been, the official language of systematic botany; the one and only language which all systematic botanists are supposed to be able to read and understand. It is our universal medium of expression. It is, therefore, hardly reasonable to expect that important contributions shall obtain wide recognition unless given in that official language. Or, if that seem too dogmatic, disputed it can not be, that a botanical book, or page, or paragraph published in Latin obtains at least a much wider and more general publication than it can attain to in any other language. This is why every great standard of taxonomy, at present, as through the past, is sure to be in Latin. But, as has been intimated, every extension of a plant genus, and every attempt to indicate and circumscribe a new group, is an important item, a new landmark, so to speak, in the progress of botany; and if important, the character should be given in Latin. Botanists, one and all, and to the ends of the earth, seem to me to have the right to demand this.

I have within the last decade heard now and then a complaint made by one and another of my American colleagues, that in Europe, and especially on the continent, due recognition has not been given to our contributions to taxonomy; and I have sympathized; but within the last two years, in the course of correspondence, it has become known to me that, in many an instance, the monographer who may have seemed to make little of a given piece of my own or some other man's work, has only done so because he could not pause in the midst of his own work to learn English well enough to be able to read understandingly our diagnoses. Of this aspect of the case I can not forego the mention of one illustration. The man across the sea, being obliged to make use of a new monograph of a certain genus, fell into something nearing despair at the number of new species, and expressed frankly a fear that few, if any, of them could be valid. Less than a half year later came word that the diagnoses were found susceptible of translation into Latin; that he had himself done the labor of translating them; that he now understood them and could not controvert the validity of the species.

It was really, all the while, a sort of unwritten law in botany, that diagnoses of new types should appear in Latin. To this day the botanists of Norway and Sweden, Finland and Russia and Japan, and all the way back again to southern and middle Europe, not excepting those of England and Ireland, do almost invariably, even in their monthly journals, give the characters of new forms in Latin. The law has been violated now and then and here and there in Europe, but we on

our side the Atlantic, since the passing of the fathers of the last generation, have quite recklessly transgressed, and I, as one of the chief among the transgressors, acknowledge the justice of the reprimand.

It will be questioned that the Vienna congress was truly and fairly international. Many will deny that its regulations are of binding force; and let all that even be denied. Yet the laws that are unwritten are sometimes, it may be, the most binding of all; and I can but regard this expression of the congress as its most important pronouncement; and viewed—if one so view it—as a mere recommendation, it is a most wholesome one. Edw. L. Greene.

National Museum,
Washington, D. C.

FLEAS AND DISEASE.

A new and very striking interest now attaches to investigations relative to the connection of fleas with the transmission of disease, in view of the recent specific statements that have been made in connection with the transmission of leprosy by these insects. It is perfectly true that we have very little definite knowledge of the whole matter and that opinions so far expressed are almost purely theoretical. An excellent historical résumé of the subject is given by Dr. Herzog in Bulletin No. 23 of the Bureau of Government Laboratories at Manila. He tells of various efforts to find plague bacilli in fleas or to produce the disease by allowing fleas from diseased rats to bite healthy individuals. Here he might have referred back to Yersin's experience in failing to find the bacilli in the blood from other parts of the body when they were multitudinous in the buboes, and he should have suggested that a flea might have a similar experience. Such a view-point might invalidate much if not most of the experimental work so far accomplished. The 'severe and just' criticisms of Galli-Valerio, made at a time when he was not even acquainted with the species of fleas infesting rats in regions ravaged by the plague, are scarcely worthy of consideration one way or the other. The only serious work on the subject was begun at Sydney, where there was a proper effort to first know the fleas and then to determine if any of the species infesting rats would also bite human beings. Investigators there found *Pulex pallidus* common on rats. This is a very near relative of *P. irritans* and was experimentally determined as able and willing to bite human beings, as might have been expected theoretically. The singling out of this species from all the others found there on rats was a distinct step in advance.

The verdict of the Indian Plague Commission was: No evidence, one way or the other. Indeed, all the way through this discussion, a point that strikes the unprejudiced reader more strongly than any other is the startling paucity of facts—actual observations and experiments—on which all the theories, for and against, have been built. Apparently the most categorical statements are coming from men who do not know the rat fleas of the tropics and subtropics at all. Dr. Herzog adds nothing in the way of adequate experiment, but submits the description of a 'new rat flea'—*Pulex philippinensis*—which may or may not be new, since the description does not include a single diagnostic character to make possible comparisons with any other species. The photographs presented, which are exceedingly poor in detail, indicate a form extremely close to *Pulex irritans,* the flea specific to human beings, which species has, by the way, been taken from rats, cats, dogs, foxes and other animals in regions where it is abundant, a fact of striking importance in this investigation.

There are some most important aspects of the case which have as yet not been considered at all. Most fleas are epicures in their blood-sucking habits where mosquitoes are gluttons. They do not settle and gorge themselves, as do the mosquitoes, but pass rapidly from place to place and bite often. A single flea has been observed to bite so as to leave a dozen or more inflamed spots in as many minutes and yet its abdomen show no extraordinary dilation. The flea possesses a remarkable puncturing apparatus, portions having the appearance of a double-edged saw, with an intricately developed serration. It seems likely that the

flea would have difficulty in wiping its mouth clean after a meal, and indeed microscopical examination made soon after a flea has bitten will reveal blood upon its external mouth parts. If these are snipped off and teased out in a drop of water many blood corpuscles may be found, and if these occur then surely it would be possible for numberless bacilli to lodge there also. This is merely a suggestion —no one known to me has examined the matter properly. Theoretically, a flea drinking blood from a malignant buboe would be pretty likely to have a stomach well filled with the bacilli, and this is said to be the case with the plague as well as with leprosy, though what future relation material that has once passed the flea's throat may have to human beings it is for the bacteriologist to discover, if, indeed, this fact has any bearing of importance whatever. According to Dr. Herzog, Zirolia says that 'the feces of fleas from plague-infected animals contain virulent bacilli, and that in the bodies of the dead fleas these parasites survive for a long time,' though as usual, one of the most important facts—the name of the flea studied—is not given. If a flea bites a malignant buboe and then passes to a healthy individual and inserts the proboscis above described beneath the skin, the bacteriologist is to say what chance there is for inoculation in the inflamed flea-bite, certainly a better chance than with a thrust made by a needle. Seemingly there is almost a physical impossibility that bacilli should not be transferred. In the case of leprosy, a flea which has inserted the above-described proboscis into a malignant lepra blotch is *persona non grata* so far as I am concerned—I would rather not have him transfer his attention to any part of my body, even though I be in more or less ignorance of the possibilities of the case as related to actual infection, resistance or receptivity of different tissues inoculated, etc. Such a statement as Dr. Herzog makes concerning the work of Thompson at Sydney must, it seems to me, serve as a striking call for further investigation. He says, 'Thompson observed blebs which he considered to be produced by fleas and to be the place of entrance of the plague virus, concluding that the transmission of plague from rats and mice through the intermediation of fleas must be frequent.'

The conflict of opinion all along the line has been amusing when the almost utter lack of definite knowledge on the subject is considered. For instance, in all the talk of rat fleas biting human beings, scarcely a mention has been made of *Pulex irritans* biting rats, though where this species is abundant this is a common occurrence. All theories must be examined, however improbable, from every point of view, and thoroughly sifted, and then the workable residue may form a useful guide for the broadly planned and properly executed experimentation of the future—the only kind of work that will really count.

Surely here is a subject of prime importance calling loudly for systematic and thorough investigation. For after the years of work of specialists and commissions, the plague is still claiming its thousands, and is now on our own shores, and we have to make the fearful admission that the dread blight of leprosy has not only a firm foothold within the United States, but is rapidly spreading, as new localities become infected. It seems as if even the few considerations mentioned above indicated clearly and definitely abundant need for the following initiative lines of work:

I. *Extensive collecting of the fleas infesting rats, cats, dogs and especially human beings, in all parts of the world, but more particularly and thoroughly in all plague- and leprosy-infested regions.* Of such prime importance does the writer consider this preliminary investigation that he recently offered to take all the risks incident to such work and prosecute it vigorously and thoroughly in all the worst plague- and leprosy-infested regions. His somewhat extended experience in tropical field work and special knowledge of the subject seemed to justify and call for such an offer. Whether it will elicit any response remains to be seen. The striking need of the investigation can not be doubted.

II. *An extended and thorough systematic and anatomic study of the species as is now being carried on by the United States government in the case of mosquitoes.* The writer has had such work in progress at his personal

expense for many years and has published a number of papers relating to it.

An invitation has been extended to medical men and others the world over to cooperate. This cooperation, while of the greatest importance, and indeed in default of any of the other support so much needed—of prime importance—can only be disconnected and very incomplete.

Residence in the tropics and in a leprosy center, together with the hearty cooperation of Dr. Howard, of Washington, Dr. Carter, of the University of Texas at Galveston, and others has made possible a good beginning by the writer. Indeed, an interesting result already to be noted is that one of the common rat fleas of the southern gulf ports is the same as the common species in Havana, and of the group of tropical rat fleas closely related to *Pulex irritans*, and thus very likely to bite human beings when opportunity offers. An utter lack of extensive collections from human beings at any of these places makes useful, well-founded deductions on this point impossible. We hope to get these collections in some way. The simplicity of the apparatus needed (tweezers, small homœopathic vials of alcohol and several rat traps) should make extensive collections possible to all who are interested in the subject. Some have complained of the quick movements of the living insects, and the rapidity with which they desert dead animals, as a serious hindrance to the collecting. A little strong pyrethrum powder will remedy these difficulties. Scattered through the fur of an animal, it immediately disables the fleas, and their expiring efforts serve to carry them out, to fall on white paper, where they may be readily and rapidly gathered. As large series as possible should be taken and full data as to locality, host, etc., should be inserted in every vial. A report will be returned for all specimens sent either to the writer or to Dr. Howard, Government Entomologist in Washington, D. C., U. S. A., and full published credit will later be given for every sending.

C. F. BAKER.

ESTAÇION AGRONOMICA,
SANTIAGO DE LAS VEGAS, CUBA.

SPECIAL ARTICLES.

NOTE ON THE HABITS OF AN OPHIDIID (CUSKEEL).

IN 1871 Professor A. E. Verrill (*Am. Nat.*, 5, p. 399) published a note of half a dozen lines on the *Ophidium marginatum*, remarking that 'this species appears to be very rare and its habits little known.' He "dug two specimens out of the sand near low-water mark, where they burrowed to the depth of a foot or more. When placed upon moist sand, they burrowed into it *tail foremost* with surprising rapidity, disappearing in an instant." These are the only data known to me respecting the habits of any member of the ophidioid family. I was, therefore, much interested to receive confirmatory and additional information about the same species from Dr. E. W. Gudger, of Waynesville, N. C.

It is quite possible, if not probable, that the apparent rarity of the species results from the uncommon manner of life rather than from actual paucity in numbers. Persons generally do not look for fishes in the bare sand.

It is to be hoped that one of the investigators at the Beaufort Laboratory will obtain other specimens and study the habits and food of the species. It is probable that the period of activity is night. It would, therefore, be desirable to examine the stomach-contents as early in the morning as possible.

THEO. GILL.

A NOTE ON THE HABITS OF RISSOLA MARGINATA.

ON July 13, 1904, while walking on a sand spit, exposed at low water and lying northwest of the island on which is situated the laboratory of the United States Bureau of Fisheries at Beaufort, N. C., I noticed, thrust out of the wet sand, a conically pointed head which instantly disappeared. Throwing myself down, I immediately began with my bare hands to dig the wet sand where I had seen the head. The animal went down tail first, and so rapidly that I began to despair of capturing it. Presently, however, when I had dug below water level, this little fish was brought out in a great double handful of sand. When taken into the laboratory and put into an aquarium of run-

ning salt water, after a few struggles it turned on its side and so remained, seemingly in considerable distress, being unable to maintain itself in the normal position by its delicate filament-like ventral fins which are intramandibular in position.

I then filled a tall glass jar some eight inches deep with fine sand, introduced into it the little fish and placed it under a salt water jet. At first the fish lay quiescent on the sand, but when I returned some hours later, it had burrowed into and was never again seen on top of the sand. Frequently, however, the little fish could be seen with its body half outlined against the glass side of the aquarium. There could then be seen slow undulations of the long dorsal and anal fins together with slight bendings of the body, both motions beginning at the head and progressing towards the tail. Evidently by this means a current of water was maintained through the gill-chambers. On the surface of the sand, small conical half-filled depressions could be found. These seemed to have been formed by the fish either in burrowing into the sand or in drawing water over the gills. However, I did not notice any distinct currents through these depressions and can not positively say that they were excurrent and incurrent openings. But I am sure that there were no distinct burrows, the wet sand not having sufficient consistence to remain in shape after the withdrawal of the fish.

Bits of oyster were put into the aquarium as food for the fish, but as these were never counted I could not be sure that any had been eaten and as it was impracticable to make later an examination of the contents of the stomach of the fish, nothing can be said as to its food.

Since this fish was of no value as a live museum specimen, and as I feared that it might die of starvation, it was killed and later identified as *Rissola marginata,* one of the cuskeels. It is a cause of considerable regret that press of other work prevented a more complete study of the habits of this interesting little fish. This specimen is now in the Museum of the laboratory of the United States Bureau of Fisheries, at Beaufort.

E. W. GUDGER.

INTERNAL INFECTION OF THE WHEAT GRAIN BY RUST—A NEW OBSERVATION.

THERE are many species of the rust parasites (Uredinales) found upon cereals. Almost every type of cultivated grain is attacked by its own particular type or form of rust. These rusts are minute, thread-like, filamentous affairs. The threads are very much more minute than the branching spawn met with in mushroom culture. The threads branch very generally and spread through the tissues of the host plant in various directions. They are able to penetrate all of the soft parts of the plants upon which they live. It has usually been supposed that the threads did not spread far from each point of new infection. The filaments usually gain admission to the tissues of the leaves and stems by eroding or boring through the skin layer from the outside. Later the branching filaments become massed at certain points under the skin layer of the host plant. They then produce countless numbers of small ovoid or rounded bodies called spores. These spores are cut off or rounded off from the ends of the filaments, pressing outward under the skin layer of the host. As the spores mature, the size enlarges, and thus the skin or epidermis of the host plant is broken and pushed outward. This allows the spores access to the air and they are then carried by the wind and other agencies from plant to plant and from field to field, perhaps hundreds of miles by wind storms. Countless numbers fall to the ground and do no harm; but countless numbers are produced and thus some of them are sure to reach other host plants. This is the usual method of accounting for the spread of wheat rust.

It has usually been assumed that rusts grow only in the leaves and stems (*vegetative parts*) of their hosts, but gradually it has been learned that amongst many perennials, certain weeds and shrubs these parasites send their filaments (*hypha*) into other more permanent structures, as, for example, roots and woody stems, thus becoming perennial with the host. Observations and experiments at this experiment station have gradually convinced us of the probability that rust of wheat may sometimes thus persist. Our field experi-

ments have often suggested that rust, at times, either attacks wheat from the soil in some form or manner, not now known, as characteristic of the life history of rust, or that it may come in some manner from the seed. This will at once suggest to those who are familiar with the investigations upon the rusts of cereals, the studies conducted by Professor Ericksson, of Stockholm, and his odd and undemonstratable mycoplasm theory. That author by his experiments seems to have demonstrated that in some manner a rust of wheat (*Puccinia glumarum*) of that region can be transmitted by the seeds, and claims to have demonstrated by structure studies certain micro-protoplasmic bodies directly associated with the cellular structure of the young wheat plant in such a manner that they are able to transmit the rust infection by finally transforming into filamentous structures in the aftergrowth from the embryo.

Through persistent studies upon this phase of the rust question we are now able to point out a more rational possible explanation of the transmission of rust through the seed of wheat, if it really ever is transmitted in that manner. Professor Ericksson in his experiments enclosed wheat from the time it was seeded until the time of maturity in certain germ proof glass cages and found that rust still appeared in the crop.[1] Bolley at the North Dakota Experiment Station several times duplicated this work.[2] He used sound wheat grains externally treated and in no case was able to secure rust under the conditions of culture; that is, was unable to confirm the results of Ericksson. It is possible that the wrong kind of wheat was selected in order to prove this work. In the experiments just cited, Bolley used the best selected grains of a particular kind of wheat which was known to rust easily. It was not certain, however, that the grains used had grown on rust-attacked mother plants. Late observations at the North Dakota Experiment Station Botanical Laboratory, in which numerous samples of wheat harvested from the badly rusted crop of 1904 were examined, now allow us to make the definite statement that wheat grains from badly rusted mother plants quite often, indeed, in some strains are quite uniformly internally infected by wheat rust filaments to such extent that spore beds are formed bearing both uredo-spores and teleuto-spores (*summer spores and winter spores*) beneath the bran layer. In some samples of the rust-infected crop of 1904, as high as thirty per cent. of all grains harvested were so infected with the stem rust (*Puccinia graminis*) and spore beds bearing both types of spores were found variously located beneath the bran layer of the grains and about the embryo wheat plants. The spots or spore beds are most commonly located immediately at the germ end, causing a black or blighted appearance, but are often found on other portions of the berry, especially along margins of the grooves. It is also found that these grains, thus affected, germinate as freely as any other wheat grains.

These new observations have opened up a new line of investigation, but it is too early to affirm that wheat rust attacks may come in this direct manner from the seed. If, however, later experiments should confirm this possible mode of rust propagation, these observations must undoubtedly throw a new light upon the Ericksson mycoplasm controversy and place another strong emphasis on the importance of proper seed selection and grading of grain in farm practise. The fact that rust thus attacks the wheat grain by way of its attachment is also an apparent explanation of why rusted wheat often fails to properly mature the seed even though there is yet plenty of strength in the parent plants.

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F. J. PRITCHARD.
NORTH DAKOTA AGRICULTURAL COLLEGE,
July 11, 1905.

[1] Dr. Jacob Ericksson, 'A General Review of the Principal Results of Swedish Research into Grain Rust,' *Botanical Gazette*, Vol. XXV., No. 1, 1898.

[2] Bolley, in *Centralblatt für Bacteriologie, Parasitenkunde und Infectionskrankheiten*, Zweite Abteilung, IV. Band, 1898, Nos. 23, 24 and 25.

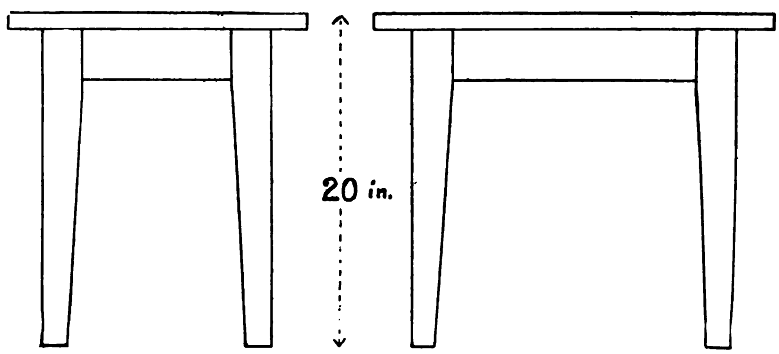
APPARATUS TABLES FOR ELECTRICAL LABORATORIES.

THE apparatus tables, here described, were designed to meet the needs of an advanced laboratory in electrical measurements. The

novelty is not one of design, but one of application. This, together with the fact that the decided advantages possessed by the tables are so obvious, makes one doubt if the utilization of such tables for an electrical laboratory is new.

The accompanying diagram will show the actual dimensions of the tables. They are built of hardwood and made heavy in order to withstand any usage. Upon the tables can be fastened any permanent equipment such as reversing keys, switches, etc. Inasmuch as these tables seem to satisfy the needs of a galvanometer, this is usually not necessary. It therefore often happens that economy of space is a very important factor in the consideration of laboratory plans. With such small tables (top 18 in. by 24 in.) the observer occupies just that floor space which he needs. Not only can he make up a table of the proper area by combining two or more of the small tables, but he also can group them to suit the conditions. It is an application of the 'unit system.'

4. A laboratory would find the tables useful not only in work in electricity, but as general



laboratory for electrical measurements so perfectly, I venture to call attention to some of their most marked advantages.

1. If the apparatus of the student, such as resistance boxes, condensers, etc., be arranged before him on a table of the ordinary height, it will be very inconvenient for him to make any adjustments, or to make any examination of his connections without rising from his seat; both because of the distance he has to reach, and because he can not see sufficiently well. If tables only twenty inches in height are used, everything is in clear view and also within easy reach. It matters not whether the student is using a galvanometer and telescope and scale, or whether he is reading ammeters and voltmeters, the advantage is the same.

2. The greater convenience of the student means a greater accuracy in his work.

3. Some experiments require comparative isolation from magnetic disturbances, but, on account of the perfection of the D'Arsonval utility tables. They can be easily lifted and carried about. They are convenient in the research laboratory, in the lecture room, and no doubt in many places about a laboratory.

G. W. STEWART.

UNIVERSITY OF NORTH DAKOTA,
February, 1905.

QUOTATIONS.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

A MAJORITY decision by the full bench of the Supreme Court, to the effect that the Massachusetts Institute of Technology can not sell its present property under the grant of 1861 and can not build over more than one third of the area bounded by Berkeley, Newbury, Clarendon and Boylston streets, seems to be the final word in a matter that has attracted much more than local attention for several years. This result will produce somewhat mingled public emotions. The rapid development of this institution in considerably less than half a century was unforeseen by most of

those who were interested in its founding. Perhaps it did not escape the faith or the vision of President Rogers, but he was unable to make those through whom he had to work see the future from his point of view, and had to be content with concessions that fell somewhat short of what he would have desired.

It is not strange that those who in this later day are responsible for the welfare of the institute should chafe under the restrictions of the original conditions and make an effort to secure greater freedom. The public has doubtless sympathized with them in that undertaking. It likes to see a service that is so broad and vital have a free field for its development. But the court decision makes all further discussion of this feature of the case unprofitable and we do not see that anything remains for the institute to do but to remain where it is and make the best of it. That 'best' can be very fruitful. The desire to obtain a more expansive location was based more on social considerations than on those which make for its main service. Doubtless the enlargement of social opportunities between students and classes would be a desirable feature of the life of the institution, but its fame and its usefulness can continue with unabated growth even with such expansion as is possible under existing conditions.

It certainly ought to be easy to reconcile the Boston public to this final judgment. It assures us the continuance of dignified and noble buildings and open spaces in a vicinity that we have been careful to guard against the invasions of commercialism. It will stand as a temple of science that is in harmony with its surroundings. It will continue to show to our own people and to the stranger within our gates that provision has been made for higher prizes than those of mere worldly gain. While Boston would prefer to keep its distinguished features by some other tie than that of duress, she can not be altogether inconsolable over the prospect that the Institute of Technology is likely to remain, in location, at least, a Boston institution.

It appears to be assumed in some quarters that this decision makes of no effect the tentative steps that have been taken toward a merger with the university beyond the Charles. This conclusion may be somewhat hasty, but should negotiations to that end still continue they will have to undergo a very radical change in terms. The plan which has been under consideration was based upon conditions that no longer exist, and that fact may or may not be fatal to the entire project. Should the decision have the effect of ending it, there is at least a very large proportion of the alumni who would not greatly mourn over the compulsion that seems to confine the institute to its present location. That it must expand is inevitable, and, while that may be more difficult than would be the case in some other section, it is by no means impossible, and the situation ought to awaken among its friends fresh zeal in its behalf.—*The Boston Transcript.*

NOTES ON INORGANIC CHEMISTRY.

TANTALUM AND ITS ALLOYS.

PATENTS have recently been taken out by Messrs. Siemens, Halske and Company, of Berlin, for tantalum alloys, which promise to be of much interest. The engineering supplement of the London *Times* gives quite a full description of the properties of the metal taken from the patent specifications, from which we note the following.

The metal is exceedingly strong and has great elasticity, and like steel is easily worked and hardened. Great hardness is imparted to it by small quantities of carbon, but other elements such as oxygen, hydrogen, silicon, boron, aluminum, titanium and tin can also be used. Very small traces of these elements are necessary to give hardness, and if larger quantities are used, the metal becomes very brittle and unworkable. In some cases the hardness attained is almost equal to that of the diamond. Like iron, tantalum, after being worked into shape, can be 'case hardened' by heating to redness in carbon. At ordinary temperatures tantalum is wholly unaffected by the atmosphere and resists the action of most acids. After being melted or highly heated the metal is comparatively soft and

easily worked, but with the working it gains rapidly in hardness, and must be carefully reheated or annealed before it can be further worked. As at high temperatures it is readily oxidized, its heating or fusion is best accomplished in a vacuum and by means of the electric current. Alloys of iron with a very small quantity of tantalum, and of tantalum with a very small quantity of iron seem to have an especial value. Owing to its great cost at present, the use of tantalum is necessarily very restricted, but if it shall ever be obtainable in considerable amounts it will have great value, especially for those parts of machinery which are subject to strong mechanical action, such as the cones and balls for ball bearings, cams, eccentrics and rollers.

TIN, TITANIUM AND COBALT STEELS.

IN a recent number of the *Comptes Rendus*, Guillet describes a study of a number of steels, some of which have already been more or less investigated by others. He finds that tin dissolves readily in iron, and if present to the extent of more than one per cent. renders the steel very hard but brittle. The carbon present never separates out as graphite. The mechanical properties of the titanium steels, when the proportion of titanium is not above nine per cent., are practically those of steel itself. The presence of cobalt, up to sixty per cent., has no effect upon the micro-structure of the steel and very little effect upon its mechanical properties. Guillet concludes from his investigations that none of these steels has any industrial value. This result is not wholly in accord with the work of other previous investigators, who have found that certain of these alloys, notably some of the titanium steels, give promise of industrial usefulness.

COPPER AS AN ANTISEPTIC AGAINST TYPHOID ORGANISMS.

QUITE an extensive paper has recently appeared in the *American Journal of Pharmacy* by Henry Kraemer, entitled 'The Use of Copper in Destroying Typhoid Organisms, and the Effects of Copper on Man.' After discussing the distribution and removal or destruction of typhoid organisms, the effect of copper on lower animals and plants is considered. The effect of water treated with copper on man and the elimination of the copper from water are next taken up, and finally the effect of copper in foods. It is, perhaps, worth while to quote the author's conclusions:

1. It is pretty well established that the typhoid organism is disseminated not only through water, but also through air and food, and may retain its vitality for a considerable period of time.
2. Typhoid organisms in water are eliminated by filtration, boiling and certain biochemical methods. Of the latter, the use of copper, as proposed by Moore and Kellermann, is probably the most efficient and at the same time most practicable.
3. While exceedingly minute quantities of copper in solution are toxic to certain unicellular organisms, as bacteria, it is safe to assume that the higher plants and animals, including man, are unaffected by solutions containing the same or even larger amounts of copper.
4. There being a number of factors which tend to eliminate copper from its solutions, it is hardly likely that there would be any copper in solution by the time the water from a reservoir reached the consumer, if the treatment of the reservoir were in competent hands.
5. Many plants contain relatively large amounts of copper, and when these are used as food some of the copper is taken up by the animal organism, but there are no records of any ill effects from copper so consumed.

In connection with this last paragraph, which is in its conclusion quite contrary to the usually accepted idea, numerous authorities and experiments are quoted, and the conclusion is probably well justified that very little danger is to be apprehended from either acute or chronic copper poisoning from copper present in water or foods.

J. L. H.

RECENT MUSEUM REPORTS.

THAT the annual report of a museum should, as a rule, appear from three months to a year late, doubtless strikes the average reader as extraordinary. But 'the average reader,' or the average man, frequently looks upon a museum as a haven of rest whose collections assemble, arrange and label themselves; as a

place where moth and dust do not corrupt and Dermestes do not break in and steal; where the employees spend their time in studies of interest only to themselves. That such is a not uncommon opinion is evidenced by the character of many who apply, or are recommended, for positions in museums, whose chief qualification seems to be inability to do a good day's work or compete with their fellow men in the daily avocations of life. As a matter of fact, to use Dr. Haddon's expression, the curator who really curates has his hands full to overflowing, and there are always so many things demanding immediate attention that in the matter of reports there is a strong temptation to follow the good old adage and not put off till to-morrow what can conveniently be put off until the day after. These remarks are called forth by the comparatively recent appearance of the belated reports of several of our museums, that of the *U. S. National Museum* for 1902–03, having appeared in June, as nearly as possible two years behind. Nevertheless the report is a good one and indicates the aid extended by this institution to the public in general and investigators in particular, and it is probably fair to say that no other museum in the world is so free with material, publications and information as this.

Where so much ground is covered as is done in this report it is practically impossible to touch on details, but one may note the rapid growth of the botanical and entomological collections and the gradual rearrangement of the zoological exhibits in the interests of the public, by lessening the number of specimens and adding to their attractive features. Just a word of criticism here: the collection of mammals is stated to be at last 'thoroughly and satisfactorily labeled.' It may be thoroughly labeled, but in view of what is now demanded of museums it can hardly be said that a set of labels giving only the name and range of the species is satisfactory. The labels on the reptiles and many of the fishes are very much better than those of the mammals and birds.

As an appendix to the report Mr. Rathbun gives 'An Account of the Buildings occupied by the National Collections' and there is a translation of the memoirs by Dr. A. B. Meyer, of the Royal Museum, Dresden, 'Studies of the Museums and Kindred Institutions of New York City, Albany, Buffalo and Chicago, with Notes on Some European Institutions.' These are both long and important articles. The first shows just how the National Museum is housed and gives a brief sketch, with plans of the new building now in process of construction. The accompanying illustrations give an extremely good idea of the general appearance of the present building and of its exhibition halls.

The publication of the translations of Dr. Meyer's memoirs makes generally accessible for the first time the fullest account of our own museums and libraries that has been written, while the notes on European museums show the most recent work in museum construction and installation.

The *Report of the American Museum of Natural History* for 1904 appeared in July and is, as usual, a somewhat condensed and formal statement of the operations of the museum, the more striking feature of general interest being skillfully emphasized by the introduction of a number of plates. These include the great bird groups, the skeleton of Brontosaurus, the Peary meteorite (which, like fish, lost so much in weighing), and examples of the beautiful glass models of invertebrates made in the museum laboratories under the supervision of Dr. Dahlgren. With all respect to the late Herr Blaschka, these models are superior to the famous Blaschka models. In its lecture courses the American Museum makes a strong appeal to teachers and scholars and the results have been extremely satisfactory.

The *Report of the Carnegie Museum* covers the year ending March 31, 1905, and this appeared with commendable promptness and shows a remarkable increase in the collections of vertebrate and invertebrate paleontology. At present the growth of the exhibition portion of the museum is stopped by the construction of the extensive additions now being made to the building, but the study collections in all departments are increasing rapidly.

The report notes the over-zealous interference of the Game Commission of Pennsylvania with the collecting of native birds. It has repeatedly been shown that it is not the scientific collector who wreaks havoc among birds, but those who destroy for commercial purposes, or for pure love of killing. With some hesitation we question the entire accuracy of the statement that 'This museum was probably the first institution of its kind to put into practical effect the idea of sending out through the schools small collections illustrating the truths of natural science.' Our English friends may have something to say regarding this rather sweeping claim.

The *Report of the Museums of the Brooklyn Institute* for 1904, is seven months after date, but, being the first of its kind, should not be too severely criticized. It notes the restrictions on the work of rearrangement due to the delay in receiving the central section of the building, but as noted in SCIENCE this restriction was removed in March and the section opened in June. There is a somewhat detailed list of the collections of art and ethnology and an account of the libraries of the Central and Children's Museums. The latter now contains over 3,500 volumes and is possibly the most complete of its kind, containing a very large proportion of popular works on natural history and nature study, history and geography, and many selected with special reference to their use by teachers. The number of readers for 1904 was 26,899, including 105 teachers with their classes.

To generalize a little it may be said that these reports emphasize the amount of attention that is properly being given to the display of specimens so that they may be both attractive and of educational value. To a great extent these things go hand in hand, for if specimens are not attractive, the visitor will not look at them closely and their educational influence is lost. The old museum idea was the exhibition of specimens only, now the specimens are used to aid in the teaching of facts.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR E. RAY LANKESTER, director of the British Museum of Natural History, was elected president of the British Association for 1906 at the final meeting of the association held at Johannesburg on September 1. After the adjournment, most of the members of the association left for Kimberly, Bulawayo and Victoria Falls.

THE advisory board of engineers upon plans for the Panama Canal, consisting of American and foreign experts, held their first meeting in Washington on September 1. They will later go to Panama. The members of the board are: Mr. Henry Hunter, nominated by the British government; M. Adolphe Guérard, nominated by the French government; Herr Eugene Tincauser, nominated by the German government; Herr J. W. Welcker, nominated by the government of the Netherlands; M. L. Quellennec, consulting engineer of the Suez Canal; General George W. Davis, U. S. A., retired; Alfred Doble, chief engineer of the Pennsylvania Railroad; William Barclay Parsons, formerly of the New York Rapid Transit Commission; Professor William H. Burr, of Columbia University; Frederick P. Stearns, of Boston; General Henry L. Abbott, U. S. A., retired; Joseph Ripley, engineer of the Sault Ste. Marie Canal, and Isham Randolph, engineer of the Chicago Drainage Canal.

DR. D. E. SALMON, for twenty-one years head of the Bureau of Animal Industry of the Department of Agriculture, handed his resignation to Secretary Wilson on September 6. The secretary accepted it, to take effect on October 1. Dr. Alonzo D. Melvin, assistant chief of the bureau, will be designated acting chief.

PROFESSOR O. LUMMER, director of the physical laboratory at Breslau, has accepted an invitation to lecture at Columbia University during the year 1906–7.

PRESIDENT DAVID STARR JORDAN, of Stanford University, has returned from Europe by way of Canada, and was expected to reach home this week.

IT appears that Professor Ronald Ross did not, as has been stated, accompany Professor Rubert Boyce on his visit to New Orleans in connection with the outbreak of yellow-fever.

It is stated in *American Medicine* that Lawrence F. Flick, of the Phipps Institute, Joseph Walsh, Mazyck P. Ravenel and D. J. McCarthy, of Philadelphia, will sail on September 16 to attend the third International Congress on Tuberculosis in Paris, where they will read papers.

Dr. Edmund Neusser, professor of medicine in the University of Vienna, has received from the emperor a life patent of nobility.

Dr. Robert Koch, who is still in east Africa, has been appointed an honorary member of the Royal Institute for Infectious Diseases, Berlin.

Dr. Julius Kuhn, known for his contributions to scientific agriculture, will celebrate his eightieth birthday on October 23.

Dr. J. A. Mayer has retired from the curatorship of the Bavarian National Museum at Munich and is succeeded by Dr. P. Halm, hitherto librarian of the museum.

Dr. H. Fischer has been appointed director of the Bacteriological Station in the Agricultural School at Berlin.

Dr. Wm. E. Ritter, director of the San Diego Marine Biological Laboratory, has been granted a leave of absence for the current academic year from his duties as professor of zoology at the University of California. He will spend the first half, at least, of the period at La Jolla, where the new laboratory of the San Diego Marine Biological Association is located, in study and in looking after the interests of the biological survey being carried on by the laboratory.

Mr. Alvin Seale, who is about to graduate from Stanford University, after special work in zoology, has been employed by the government of the Hawaiian Islands to make experiments with certain fishes from the southern states to determine whether these will exterminate the mosquitoes that have been introduced into the Hawaiian Islands.

During the field season just closed, a number of men from the department of geology, of the University of Oklahoma, have been in the field. Professor Charles N. Gould, with two advanced students, T. B. Matthews and E. F. Schramm, spent two months in the Texas Panhandle studying the geology and water resources of the region for the Division of Hydrology of the U. S. Geological Survey. Professor E. G. Woodruff during the same time has been a member of the survey party of Mr. N. H. Darton in the Big Horn Mountains, Wyoming. Mr. Ira Montgomery and Mr. L. L. Hutchinson were members of the field party of the Oklahoma Geological Survey and with Professor A. H. Van Vleet spent a number of weeks in the field in the northwestern part of Oklahoma.

Mr. Chester A. Reeds, B.S. ('05, Oklahoma), spent the summer collecting fossils from the Hunton (Helderbergian) limestone in the Arbuckle Mountains for the department of paleontology at Yale, where he has an assistant's position with Professor Schuchert the coming year.

Cavendish House and grounds, situated on the south side of Clapham, where Henry Cavendish made his remarkable experiments, has been sold at auction.

A monument in honor of Professor B. Maerckers, known for his contributions to agricultural science, will be unveiled in Halle on October 24.

Dr. Ernst Theodor Schweiger, professor of ophthalmology at Berlin, died on August 26, at the age of seventy-five years.

Dr. H. Laehr, a leading German psychiatrist, has died at the age of eighty-six years.

The health commissioner of the state of Pennsylvania has posted an entomologist at the harbor to watch fruit vessels from foreign ports, and make a collection of mosquitoes that come with the fruit. These mosquitoes will be carefully examined to ascertain if any of the yellow fever variety are reaching Philadelphia.

M. Medeiros, of Rio de Janeiro, a member of the Brazilian legislature, has submitted to the chamber of deputies the offer of a prize of £400,000 to be awarded to the discoverer of a certain means of stamping out consumption.

Sir Alfred Jones and Mr. W. H. Lever have both promised £1,000 a year for four years

towards the expenses of the proposed school of research in connection with the university. The school is to inquire into the natural resources of the tropical possessions of the empire. Lord Mountmorres is to be the first director.

THE city of Hamburg will reestablish the old astronomical observatory at Bergedorf. The observatory has been presented with 50,000 Marks for the purchase of a photographic telescope.

THE Landmarks Club for more than ten years has been safe-guarding and preserving the old missions of southern California. It has raised over $7,000 and applied these moneys in protective repairs to these monuments. It has reroofed about 60,000 square feet of the principal buildings at four missions; and by these and other repairs has saved them from destruction. If this work had not been done when it was these buildings would by now be hopeless mounds of adobe. There is far more of this work still to be done, which the Landmarks Club will do. It has long leases on three of the missions.

THE committee of the British Association of Botanical Photographs reports that forty photographs have been added to the register since the last meeting. They have been received from various persons, but it would mention in particular a series of photographs by Mr. R. Welch illustrating the coast flora of Ireland, and a number of photographs by Professor Yapp, of Aberystwyth, illustrating some aspects of the vegetation of the Malay Peninsula. A printed list has been prepared of the photographs so far contributed to the register, and this will be ready for circulation in July. The recently established committee for the Botanical Survey of Great Britain contemplates the establishment of a collection of botanical photographs of British vegetation, and it is hoped that that committee will collaborate with the committee of the British Association by taking over the work of collecting and arranging photographs relating to British vegetation.

The Experiment Station Record states that the Minnesota legislature at its recent session passed two laws of considerable importance to the agriculture of the state. One of these provides for the establishment of a branch school of agriculture at Crookston, to be a department of the University of Minnesota under the direction of the board of regents of the university. The other provides for local option in the establishment and maintenance of county schools of agriculture and domestic economy, limiting to $20,000 the amount that any county may appropriate for this purpose in one year. The initiative in the matter of establishing such schools may be taken by the people or by the county commissioners, but the county commissioners can not finally establish a school until the question has been submitted to the electors in the county. Two or more counties may unite to establish a school of agriculture and domestic economy. The schools are to be under the control of a county school board of three members, the secretary of which shall be the county superintendent of schools, and the other two members are to be elected by the county commissioners. Each school must have connected with it a tract of land, suitable for purposes of experiment and demonstration, of not less than ten acres. Tuition is to be free to residents of the county or counties contributing to its support. The state superintendent of public instruction is to have general supervision over the schools, and with the advice of the dean of the College of Agriculture is to prescribe the courses of study to be pursued.

The British Medical Journal says times have greatly changed in France, as elsewhere, since the days when Claude Bernard had for his laboratory in the Collège de France, something little better than an indifferent cellar, and Pasteur a kind of something that might have served as a granary in the Ecole Normale. But since no rule lacks an exception, we find some of the most distinguished scientists still without that provision for scientific work which would enable them to follow the bent of their genius without having to think of ways and means. Thus, in Paris, the center of academic and scientific institutions, we find M. Becquerel making with his own hands the apparatus by means of which he observed the

phenomena of radioactivity, and even until quite a short time ago M. Curie was forced to prosecute his studies in radium in a shed which, in its poverty of mechanical or other equipment, rivaled even the room under the roof in which Pasteur did some of his epoch-making work. An examination of the budget for 1904 reveals the fact that for scientific purposes the sum voted for the universities of France is over 13,000,000 francs. Besides this there is a credit of 556,500 francs for the Collège de France, with its forty professors, and, in addition, for the Museum of Natural History in the Jardin des Plantes one of over 1,000,000 francs; so that the budget for science for the past year reaches a sum of something less than £600,000. In France, as in England, the great difficulty appears to be the combination of teaching duties with those of research. The budget draws no distinction between money allocated for teaching purposes and that for research. The chief exception, perhaps, in a modified way, is that for the Collège de France. Each professor must give forty lectures per annum, but it is not possible to go on, year in year out, giving something new at every lecture. The same obtains at the museum. A professor at the Sorbonne or at the Faculty of Medicine, during six months has to devote his time to giving instruction to the students who attend his course, while a very large part of his time is necessarily consumed in the examination of the numerous candidates in the Paris Faculty.

UNIVERSITY AND EDUCATIONAL NEWS.

The University of Pennsylvania will receive $60,000 from the estate of the late Professor Maxwell Sommerville, who held a chair of archeology in the university.

President Thwing, of Western Reserve University, has announced that Mr. Andrew Carnegie had given $25,000 towards the establishment of a fund of $100,000 for the endowment of a chair of political economy at Western Reserve University, to bear the name of the late Senator Hanna.

The Dominion government has made a grant of £500 to the McGill University for work in railway engineering and transportation. This is the government's contribution, as owner of the Inter-Colonial, to a scheme to which the Grand Trunk and Canadian-Pacific have given £1,000, and the Canadian Northern £400, for the instruction of young men in railway construction and operation.

The Board of Trustees of the University of the Pacific has ordered the museum moved from West Hall to East Hall where it will have more commodious quarters. New cases will be constructed for collections not now on exhibition. Funds have also been appropriated with which to purchase additional apparatus for the geological and chemical laboratories to meet the demand of an increasing number of students in these departments.

Owing to the interruption of travel caused by the quarantines against New Orleans and other infected points, it has been decided to postpone the opening of the session of the Louisiana State University until October 18. By that time the yellow fever will, it is hoped, be under such complete control and the quarantines so relaxed that unrestricted travel may be resumed on all railroads. There is no yellow fever in Baton Rouge, and there is every reason to believe that the efforts of the health authorities to prevent its introduction there will continue to be successful.

Mr. Clarence E. Reid, of the National Bureau of Standards, has been appointed assistant professor of electrical engineering in the Case School of Applied Science.

Mr. Arthur H. Ford, professor of electrical engineering at the Georgia School of Technology, Atlanta, Georgia, has been appointed professor and head of the department of electrical engineering in the College of Applied Science of the State University of Iowa.

The Experiment Station Record states that Professor F. Wohltmann, for ten years director of the agricultural experiment station at Bonn-Poppelsdorf, and professor of agriculture in the academy, has accepted a call to Halle. In his lectures at Halle Professor Wohltmann will include a course in tropical agriculture with special reference to the German colonies.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, SEPTEMBER 22, 1905.

CONTENTS.

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE PROGRESS OF PHYSICS IN THE NINETEENTH CENTURY.[1]

I.

Mr. President, Ladies and Gentlemen: You have honored me by requesting at my hands an account of the advances made in physics during the nineteenth century. I have endeavored, in so far as I have been able, to meet the grave responsibilities implied in your invitation; yet had I but thought of the overwhelmingly vast territory to be surveyed, I well might have hesitated to embark on so hazardous an undertaking. To mention merely the *names* of men whose efforts are linked with splendid accomplishments in the history of modern physics would far exceed the time allotted to this address. To bear solely on certain subjects, those for instance with which I am more familiar, would be to develop an unsymmetrical picture. As this is to be avoided, it will be necessary to present a straightforward compilation of all work above a certain somewhat vague and arbitrary lower limit of importance. Physics is, as a rule, making vigorous though partial progress along independent parallel lines of investigation, a discrimination between which is not possible until some cataclysm in the history of thought ushers in a new era. It will be essential to abstain from entering into either explanation or criticism and to assume that all present are familiar with the details of the subjects to be treated. I can neither popularize nor can I endeavor to entertain, except in so far as a rapid review of the glorious conquests of the century may be stimulating.

In spite of all this simplicity of aim, there is bound to be distortion. In any brief account, the men working at the beginning of the century, when investigations were few and the principles evolved necessarily fundamental, will be given greater consideration than equally able and abler

[1] Paper read at the International Congress in St. Louis.

investigations near the close, when workers (let us be thankful) were many, and the subjects lengthening into detail. Again, the higher order of genius will usually be additionally exalted at the expense of the less gifted thinker. I can but regret that these are the inevitable limitations of the cursory treatment prescribed. As time rolls on the greatest names more and more fully absorb the activity of a whole epoch.

METROLOGY.

Finally, it will hardly be possible to consider the great advances made in physics except on the theoretical side. Of renowned experimental researches, in particular of the investigations of the constants of nature to a degree of ever increasing accuracy, it is not practicable to give any adequate account. Indeed, the refinement and precision now demanded have placed many subjects beyond the reach of individual experimental research, and have culminated in the establishment of the great national or international laboratories of investigation at Sèvres (1872), at Berlin (1887, 1890), at London (1900), at Washington (1901). The introduction of uniform international units in cases of the arts and sciences of more recent development is gradually, but inexorably, urging the same advantages on all. Finally, the access to adequate instruments of research has everywhere become an easier possibility for those duly qualified, and the institutions and academies which are systematically undertaking the distribution of the means of reasearch are continually increasing in strength and in number.

CLASSIFICATION.

In the present paper it will be advisable to follow the usual procedure in physics, taking in order the advances made in dynamics, acoustics, heat, light and electricity. The plan pursued will, therefore, specifically consider the progress in elastics, crystallography, capillarity, solution, diffusion, dynamics, viscosity, hydrodynamics, acoustics; in thermometry, calorimetry, thermodynamics, kinetic theory, thermal radiation; in geometric optics, dispersion, photometry, fluorescence, photochemistry, interference, diffraction, polarization, optical media; in electrostatics, Volta contacts, Seebeck contacts, electrolysis, electric current, magnetism, electromagnetism, electrodynamics, induction, electric oscillation, electric field, radioactivity.

Surely this is too extensive a field for any one man! Few who are not physicists realize that each of these divisions has a splendid and voluminous history of development, its own heroes, its sublime classics often culled from the activity of several hundred years. I repeat that few understand the unmitigatedly fundamental character, the scope, the vast and profound intellectual possessions, of pure physics; few think of it as the one science into which all other sciences must ultimately converge —or a separate representation would have been given to most of the great divisions which I have named.

Hence even if the literary references may be given in print with some fullness, it is impossible to refer verbally to more than the chief actors and quite impossible to delineate sharply the real significance and the relations of what has been done. Moreover, the dates will in most instances have to be omitted from the reading. It has been my aim, however, to collect the greater papers in the history of physics, and the suggestion is implied that science would gain if by some august tribunal researches of commanding importance were formally canonized for the benefit of posterity.

ELASTICS.

To begin with elasticity, whose development has been of such marked influ-

ence throughout the whole of physics, we note that the theory is virtually a creation of the nineteenth century. Antedating Thomas Young, who in 1807 gave to the subject the useful conception of a modulus, and who seems to have definitely recognized the shear, there were merely the experimental contribution of Galileo (1638), Hooke (1660), Mariotte (1680), the elastic curve of J. Bernoulli (1705), the elementary treatment of vibrating bars of Euler and Bernoulli (1742), and an attempted analysis of flexure and torsion by Coulomb (1776).

The establishment of a theory of elasticity on broad lines begins almost at a bound with Navier (1821), reasoning from a molecular hypothesis to the equation of elastic displacement and of elastic potential energy (1822–1827); yet this startling advance was destined to be soon discredited, in the light of the brilliant generalizations of Cauchy (1827). To him we owe the six component stresses and the six component strains, the stress quadric and the strain quadric, the reduction of the components to three principal stresses and three principal strains, the ellipsoids and other of the indispensable conceptions of the present day. Cauchy reached his equations both by the molecular hypothesis and by an analysis of the oblique stress across an interface—methods which predicate fifteen constants of elasticity in the most general case, reducing to but one in the case of isotropy. Cotemporaneous with Cauchy's results are certain independent researches by Lamé and Clapeyron (1828) and by Poisson (1829).

Another independent and fundamental method in elastics was introduced by Green (1837), who took as his point of departure the potential energy of a conservative system in connection with the Lagrangian principle of virtual displacements. This method, which has been fruitful in the hands of Kelvin (1856), of Kirchhoff (1876), of Neumann (1885), leads to equations with twenty-one constants for the æolotropic medium reducing to two in the simplest case.

The wave motion in an isotropic medium was first deduced by Poisson in 1828, showing the occurrence of longitudinal and transverse waves of different velocities; the general problem of wave motion in æolotropic media, though treated by Green (1842), was attacked with requisite power by Blanchet (1840–1842) and by Christoffel (1877).

Poisson also treated the case of radial vibrations of a sphere (1828), a problem which, without this restriction, awaited the solutions of Jaerisch (1879) and of Lamb (1882). The theory of the free vibrations of solids, however, is a generalization due to Clebsch (1857–58, 'Vorlesungen,' 1862).

Elasticity received a final phenomenal advance through the long continued labors of de St. Venant (1839–55), which in the course of his editions of the work of Moigno, of Navier (1863), and of Clebsch (1864), effectually overhauled the whole subject. He was the first to adequately assert the fundamental importance of the shear. The profound researches of de St. Venant on the torsion of prisms and on the flexure of prisms appeared in their complete form in 1855 and 1856. In both cases the right sections of the stressed solids are shown to be curved and the curvature is succinctly specified; in the former Coulomb's inadequate torsion formula is superseded and in the latter flexural stress is reduced to a transverse force and a couple. But these mere statements convey no impression of the magnitude of the work.

Among other notable creations with a special bearing on the theory of elasticity there is only time to mention the invention and application of curvilinear coordinates by Lamé (1852); the reciprocal theorem

of Betti (1872), applied by Cerruti (1882) to solids with a plane boundary—problems to which Lamé and Clapeyron (1828) and Boussinesq (1879–85) contributed by other methods; the case of the strained sphere studied by Lamé (1854) and others; Kirchhoff's flexed plate (1850); Rayleigh's treatment of the oscillations of systems of finite freedom (1873); the thermo-elastic equations of Duhamel (1838), of F. Neumann (1841), of Kelvin (1878); Kelvin's analogy of the torsion of prisms with the supposed rotation of an incompressible fluid within (1878); his splendid investigations (1863) of the dynamics of elastic spheroids and the geophysical applications to which they were put.

Finally, the battle royal of the molecular school following Navier, Poisson, Cauchy and championed by de St. Venant, with the disciples of Green headed by Kelvin and Kirchhoff—the struggle of the fifteen constants with the twenty-one constants, in other words—seems to have temporarily subsided with a victory for the latter through the researches of Voigt (1887–89).

CRYSTALLOGRAPHY.

Theoretical crystallography, approached by Steno (1669), but formally founded by Haüy (1781, 'Traité,' 1801), has limited its development during the century to systematic classifications of form. Thus the thirty-two type sets of Hessel (1830) and of Bravais (1850) have expanded into the more extensive point series involving 230 types due to Jordan (1868), Sohncke (1876), Federow (1890) and Schoenfliess (1891). Physical theories of crystalline form have scarcely been unfolded.

CAPILLARITY.

Capillarity antedated the century in little more than the provisional, though brilliant, treatment due to Clairaut (1743). The theory arose in almost its present state of perfection in the great memoir of Laplace (1805), one of the most beautiful examples of the Newton-Boscovichian (1758) molecular dynamics. Capillary pressure was here shown to vary with the principal radii of curvature of the exposed surface, in an equation involving two constants, one dependent on the liquid only, the other doubly specific for the bodies in contact. Integrations for special conditions include the cases of tubes, plates, drops, contact angle, and similar instances. Gauss (1829), dissatisfied with Laplace's method, virtually reproduced the whole theory from a new basis, avoiding molecular forces in favor of Lagrangian displacements, while Poisson (1831) obtained Laplace's equations by actually accentuating the molecular hypothesis; but his demonstration has since been discredited. Young in 1805 explained capillary phenomena by postulating a constant surface tension, a method which has since been popularized by Maxwell ('Heat,' 1872).

With these magnificent theories propounded for guidance at the very threshold of the century, one is prepared to anticipate the wealth of experimental and of detailed theoretical research which has been devoted to capillarity. Among these the fascinating monograph of Plateau (1873), in which the consequences of theory are tested by the behavior both of liquid lamellæ and by suspended masses, Savart's (1833), and particularly Rayleigh's, researches with jets (1879–83), Kelvin's ripples (1871), may be cited as typical. Of peculiar importance, quite apart from its meteorological bearing, is Kelvin's deduction (1870) of the interdependence of surface tension and vapor pressure when varying with the curvature of a droplet.

DIFFUSION.

Diffusion was formally introduced into physics by Graham (1850). Fick (1855),

appreciating the analogy of diffusion and heat conduction, placed the phenomenon on a satisfactory theoretical basis, and Fick's law has since been rigorously tested, in particular by H. F. Weber (1879).

The development of diffusion from a physical point of view followed Pfeffer's discovery (1877) of osmotic pressure, soon after to be interpreted by vant' Hoff (1887) in terms of Boyle's and Avogadro's laws. A molecular theory of diffusion was thereupon given by Nernst (1887).

DYNAMICS.

In pure dynamics the nineteenth century inherited from the eighteenth that unrivaled feat of reasoning called by Lagrange the 'Mécanique Analytique' (1788), and the great master was present as far as 1813 to point out its resources and to watch over the legitimacy of its applications. Throughout the whole century each new advance has but vindicated the preeminent power and safety of its methods. It triumphed with Maxwell (1864), when he deduced the concealed kinetics of the electromagnetic field, and with Gibbs (1876–78), when he adapted it to the equilibrium of chemical systems. It will triumph again in the electromagnetic dynamics of the future.

Naturally there were reactions against the tyranny of the method of 'liaisons.' The most outspoken of these, propounded under the protection of Laplace himself, was the celebrated 'mécanique physique' of Poisson (1828), an accentuation of Boscovich's (1758) dynamics, which permeates the work of Navier, Cauchy, de St. Venant, Boussinesq, even Fresnel, Ampère and a host of others. Cauchy in particular spent much time to reconcile the molecular method with the Lagrangian abstractions. But Poisson's method, though sustained by such splendid genius, has, nevertheless, on more than one occasion—in capillarity, in elastics—shown itself to be untrustworthy. It was rudely shaken when, with the rise of modern electricity, the influence of the medium was more and more pushed to the front.

Another complete reconstruction of dynamics is due to Thomson and Tait (1867), in their endeavor to gain clearness and uniformity of design, by referring the whole subject logically back to Newton. This great work is the first to make systematic use of the doctrine of the conservation of energy.

Finally, Hertz (1894), imbued with the general trend of cotemporaneous thought, made a powerful effort to exclude force and potential energy from dynamics altogether—postulating a universe of concealed motions such as Helmholtz (1884) had treated in his theory of cyclic systems, and Kelvin had conceived in his adynamic gyrostatic ether (1890). In fact the introduction of concealed systems and of ordered molecular motions by Helmholtz and Boltzmann has proved most potent in justifying the Lagrangian dynamics in its application to the actual motions of nature.

The specific contributions of the first rank which dynamics owes to the last century, engrossed as it was with the applications of the subject, or with its mathematical difficulties, are not numerous. In chronological order we recall naturally the statics (1804) and the rotational dynamics (1834) of Poinsot, all in their geometrical character so surprisingly distinct from the cotemporary dynamics of Lagrange and Laplace. We further recall Gauss's principle of least constraint (1829), but little used, though often in its applications superior to the method of displacement; Hamilton's principle of varying action (1834) and his characteristic function (1834, 1835), the former obtainable by an easy transition from D'Alembert's prin-

ciple and by contrast with Gauss's principle, of such exceptional utility in the development of modern physics; finally the development of the Leibnitzian doctrine of work and *vis viva* into the law of the conservation of energy, which more than any other principle has consciously pervaded the progress of the nineteenth century. Clausius's theorem of the 'Virial' (1870) and Jacobi's (1866) contributions should be added among others.

The potential, though contained explicitly in the writings of Lagrange (1777), may well be claimed by the last century. The differential equation underlying the doctrine had already been given by Laplace in 1782, but it was subsequently to be completed by Poisson (1827). Gauss (1813, 1839) contributed his invaluable theorems relative to the surface integrals and force flux, and Stokes (1854) his equally important relation of the line and the surface integral. Legendre (published 1785) and Laplace (1782) were the first to apply spherical harmonics in expansions. The detailed development of volume surface and line potential has enlisted many of the ablest writers, among whom Chasles (1837, 1839, 1842), Helmholtz (1853), C. Neumann (1877, 1880), Lejeune-Dirichlet (1876), Murphy (1833) and others are prominent.

The gradual growth of the doctrine of the potential would have been accelerated, had not science to its own loss overlooked the famous essay of Green (1828) in which many of the important theorems were anticipated, and of which Green's theorem and Green's function are to-day familiar reminders.

Recent dynamists incline to the uses of the methods of modern geometry and to the vector calculus with continually increasing favor. Noteworthy progress was first made in this direction by Moebius (1837–43, 'Statik,' 1838), but the power of these methods to be fully appreciated required the invention of the 'Ausdehnungslehre,' by Grassmann (1844), and of 'quaternions,' by Hamilton (1853).

Finally the profound investigations of Sir Robert Ball (1871, et seq., 'Treatise') on the theory of screws with its immediate dynamical applications, though as yet but little cultivated except by the author, must be reckoned among the promising heritages of the twentieth century.

On the experimental side it is possible to refer only to researches of a strikingly original character like Foucault's pendulum (1851) and Fizeau's gyrostat; or like Boys's (1887, et seq.) remarkable quartz-fiber torsion-balance, by which the Newtonian constant of gravitation and the mean density of the earth originally determined by Maskelyne (1775–78) and by Cavendish (1798) were evaluated with a precision probably superior to that of the other recent measurements, the pendulum work of Airy (1856) and Wilsing (1885–87), or the balance methods of Jolly (1881), König and Richarz (1884). Extensive transcontinental gravitational surveys like that of Mendenhall (1895) have but begun.

HYDRODYNAMICS.

The theory of the equilibrium of liquids was well understood prior to the century even in the case of rotating fluids, thanks to the labors of Maclaurin (1742), Clairaut (1743) and Lagrange (1788). The generalizations of Jacobi (1834) contributed the triaxial ellipsoid of revolution and the case has been extended to two rotating attracting masses by Poincaré (1885) and Darwin (1887). The astonishing revelations contained in the recent work of Poincaré are particularly noteworthy.

Unlike elastics, theoretical hydrodynamics passed into the nineteenth century in a relatively well-developed state. Both types of the Eulerian equations of motion

(1755, 1759) had left the hands of Lagrange (1788) in their present form. In relatively recent time, H. Weber (1868) transformed them in a way combining certain advantages of both, and another transformation was undertaken by Clebsch (1859). Hankel (1861) modified the equation of continuity, and Svanberg and Edlund (1847) the surface conditions.

Helmholtz in his epoch-making paper of 1858 divided the subject into those classes of motion (flow in tubes, streams, jets, waves) for which a velocity potential exists and the vortex motions for which it does not exist. This classification was carried even into higher orders of motion by Craig and by Rowland (1881). For cases with a velocity potential, much progress has been made during the century in the treatment of waves, of discontinuous fluid motion, and in the dynamics of solids suspended in frictionless liquids. Kelland (1844), Scott Russel (1844) and Green (1837) dealt with the motion of progressive waves in relatively shallow vessels, Gerster (1804) and Rankine (1863) with progressive waves in deep water, while Stokes (1846, 1847, 1880) after digesting the contemporaneous advances in hydrodynamics, brought his powerful mind to bear on most of the outstanding difficulties. Kelvin introduced the case of ripples (1871), afterwards treated by Rayleigh (1883). The solitary wave of Russel occupied Boussinesq (1872, 1882), Rayleigh (1876) and others; group waves were treated by Reynolds (1877) and Rayleigh (1879). Finally the theory of stationary waves received extended attention in the writings of de St. Venant (1871), Kirchhoff (1879) and Greenhill (1887). Early experimental guidance was given by the classic researches of C. H. and W. Weber (1825).

The occurrence of discontinuous variation of velocity within the liquid was first fully appreciated by Helmholtz (1868), later by Kirchhoff (1869), Rayleigh (1876), Voigt (1885) and others. It lends itself well to conformal representations.

The motions of solids within a liquid have fascinated many investigators and it is chiefly in connection with this subject that the method of sources and sinks was developed by English mathematicians, following Kelvin's method (1856) for the flow of heat. The problem of the sphere was solved more or less completely by Poisson (1832), Stokes (1843), Dirichlet (1852); the problem of the ellipsoid by Green (1833), Clebsch (1858), generalized by Kirchhoff (1869). Rankine treated the translatory motion of cylinders and ellipsoids in a way bearing on the resistance of ships. Stokes (1843) and Kirchhoff entertain the question of more than one body. The motion of rings has occupied Kirchhoff (1869), Boltzmann (1871), Kelvin (1871), Bjerknes (1879) and others. The results of C. A. Bjerknes (1868) on the fields of hydrodynamic force surrounding spheres, pulsating or oscillating, in translatory or rotational motion accentuate the remarkable similarity of these fields with the corresponding cases in electricity and magnetism and have been edited in a unique monograph (1900) by his son. In a special category belong certain powerful researches with a practical bearing, such as the modern treatment of ballistics by Greenhill and of the ship propeller of Ressel (1826), summarized by Gerlach (1885, 1886).

The numerous contributions of Kelvin (1888, 1889) in particular have thrown new light on the difficult but exceedingly important question of the stability of fluid motion.

The century, moreover, has extended the working theory of the tides due to Newton (1687) and Laplace (1774), through the labors of Airy, Kelvin and Darwin.

Finally the forbidding subject of vortex motion was gradually approached more and more fully by Lagrange, Cauchy (1815, 1827), Svanberg (1839), Stokes (1845); but the epoch-making integrations of the differential equations together with singularly clear-cut interpretations of the whole subject are due to Helmholtz (1858). Kelvin (1867, 1883) soon recognized the importance of Helmholtz's work and extended it, and further advance came in particular from J. J. Thomson (1883) and Beltrami (1875). The conditions of stability in vortex motion were considered by Kelvin (1880), Lamb (1878), J. J. Thomson and others, and the cases of one or more columnar vortices, of cylindrical vortex sheets, of one or more vortex rings simple or linked, have all yielded to treatment.

The indestructibility of vortex motion in a frictionless fluid, its open structure, the occurrence of reciprocal forces, were compared by Kelvin (1867) with the essential properties of the atom. Others like Fitzgerald in his cobwebbed ether and Hicks (1885) in his vortex sponge have found in the properties of vortices a clue to the possible structure of the ether. Yet it has not been possible to deduce the principles of dynamics from the vortex hypothesis, neither is the property which typifies the mass of an atom clearly discernible. Kelvin invokes the corpuscular hypothesis of Lesage (1818).

VISCOSITY.

The development of viscous flow is largely on the experimental side, particularly for solids, where Weber (1835), Kohlrausch (1863, et seq.) and others have worked out the main laws. Stokes (1845) deduced the full equations for liquids. Poiseiulle's law (1847), the motion of small solids in viscous liquids, of vibrating plates and other important special cases, has yielded to treatment. The coefficients of viscosity defined by Poisson (1831), Maxwell (1868), Hagenbach (1860), O. E. Meyer (1863), are exhaustively investigated for gases and for liquids. Maxwell (1877) has given the most suggestive and Boltzmann (1876) the most carefully formulated theory for solids, but the investigation of absolute data has but begun. The difficulty of reconciling viscous flow with Lagrange's dynamics seems first to have been adjusted by Navier.

AEROMECHANICS.

Aerostatics is indissolubly linked with thermodynamics. Aerodynamics has not marked out for itself any very definite line of progress. Though the resistance of oblique planes has engaged the attention of Rayleigh, it is chiefly on the experimental side that the subject has been enriched, as, for instance, by the labors of Langley (1891) and Lilienthal. Langley (1897) has, indeed, constructed a steam propelled aeroplane which flew successfully; but man himself has not yet flown.

Moreover, the meteorological applications of aerodynamics contained in the profound researches of Guldberg and Mohn (1877), Ferrel (1877), Oberbeck (1882, 1886), Helmholtz (1888, 1889) and others, as well as in such investigations as Sprung's (1880) on the inertia path, are as yet rather qualitative in their bearing on the actual motions of the atmosphere. The marked progress of meteorology is on the observational side.

ACOUSTICS.

Early in the century the velocity of sound given in a famous equation of Newton was corrected to agree with observation by Laplace (1816).

The great problems in acoustics are addressed in part to the elastician, in part to the physiologist. In the former case the work of Rayleigh (1877) has described the present stage of development, interpreting

and enriching almost every part discussed. In the latter case Helmholtz (1863) has devoted his immense powers to a like purpose and with like success. König has been prominently concerned with the construction of accurate acoustic apparatus.

It is interesting to note that the differential equation representing the vibration of strings was the first to be integrated; that it passed from D'Alembert (1747) successively to Euler (1779), Bernoulli (1753) and Lagrange (1759). With the introduction of Fourier's series (1807) and of spherical harmonics at the very beginning of the century, D'Alembert's and the other corresponding equations in acoustics readily yielded to rigorous analysis. Rayleigh's first six chapters summarize the results for one and for two degrees of freedom.

Flexural vibration in rods, membranes and plates become prominent in the unique investigations of Chladni (1787, 1796, 'Akustik,' 1802). The behavior of vibrating rods has been developed by Euler (1779), Cauchy (1827), Poisson (1833), Strehlke (1833), Lissajous (1833), Seebeck (1849), and is summarized in the seventh and eighth chapters of Rayleigh's book. The transverse vibration of membranes engaged the attention of Poisson (1829). Round membranes were rigorously treated by Kirchhoff (1850) and by Clebsch (1862); elliptic membranes by Mathieu (1868). The problem of vibrating plates presents formidable difficulties resulting not only from the edge conditions, but from the underlying differential equation of the fourth degree due to Sophie Germain (1810) and to Lagrange (1811). The solutions have taxed the powers of Poisson (1812, 1829), Cauchy (1829), Kirchhoff (1850), Boussinesq (1871–79) and others. For the circular plate Kirchhoff gave the complete theory. Rayleigh systematized the results for the quadratic plate and the general account makes up his ninth and tenth chapters.

Longitudinal vibrations which are of particular importance in case of the organ pipe, were considered in succession by Poisson (1817), Hopkins (1838), Quet (1855); but Helmholtz in his famous paper of 1860 gave the first adequate theory of the open organ pipe, involving viscosity. Further extension was then added by Kirchhoff (1868), and by Rayleigh (1870, et seq.), including particularly powerful analysis of resonance. The subject in its entirety, including the allied treatment of the resonator, completes the second volume of Rayleigh's 'Sound.'

On the other hand, the whole subject of tone quality, of combination and difference tones, of speech, of harmony, in its physical, physiological and esthetic relations, has been reconstructed, using all the work of earlier investigators by Helmholtz (1862), in his masterly 'Tonempfindungen.' With rare skill and devotion König contributed a wealth of siren-like experimental appurtenances.

Acousticians have been fertile in devising ingenious methods and apparatus, among which the tuning fork with resonator of Marloye, the siren of Cagniard de le Tour (1819), the Lissajous curves (1857), the stroboscope of Plateau (1832), the manometric flames of König (1862, 1872), the dust methods of Chladni (1787) and of Kundt (1865–68), Melde's vibrating strings (1860, 1864), the phonograph of Edison and of Bell (1877), are among the more famous.

HEAT: THERMOMETRY.

The invention of the air thermometer dates back at least to Amontons (1699), but it was not until Rudberg (1837), and more thoroughly Regnault (1841, et seq.) and Magnus (1842) had completed their work on the thermal expansion and compressi-

bility of air, that air thermometry became adequately rigorous. On the theoretical side Clapeyron (1834), Helmholtz (1847), Joule (1848), had in various ways proposed the use of the Carnot function (1894) for temperature measurement, but the subject was finally disposed of by Kelvin (1849, et seq.) in his series of papers on temperature and temperature measurement.

Practical thermometry gained much from the measurement of the expansion of mercury by Dulong and Petit (1818), repeated by Regnault. It also profited by the determination of the viscous behavior of glass, due to Pernet (1876) and others, but more from the elimination of these errors by the invention of the Jena glass. It is significant to note that the broad question of thermal expansion has yet no adequate equation, though much has been done experimentally for fluids by the magnificent work of Amagat (1869, 1873, et seq.).

HEAT CONDUCTION.

The subject of heat conduction from a theoretical point of view was virtually created by the great memoir of Fourier (1822), which shed its first light here, but subsequently illumined almost the whole of physics. The treatment passed successively through the hands of many of the foremost thinkers, notably of Poisson (1835, 1837), Lamé (1836, 1839, 1843), Kelvin (1841–44) and others. With the latter (1856) the ingenious method of sources and sinks originated. The character of the conduction is now well known for continuous media, isotropic or not, bounded by the more simple geometrical forms, in particular for the sphere under all reasonable initial and surface conditions. Much attention has been given to the heat conduction of the earth, following Fourier, by Kelvin (1862, 1878), King (1893) and others.

Experimentally, Wiedemann and Franz (1853) determined the relative heat conduction of metals and showed that for simple bodies a parallel gradation exists for the cases of heat and of electrical conductivity. Noteworthy absolute methods for measuring heat conduction were devised in particular by Forbes (1842), F. Neumann (1862), Ångström (1861–64), and a lamellar method applying to fluids by H. F. Weber (1880).

CALORIMETRY.

Practical calorimetry was virtually completed by the researches of Black in 1763. A rich harvest of experimental results, therefore, has since accrued to the subjects of specific, latent and chemical heats, due in particularly important cases to the indefatigable Regnault (1840, 1845, et seq.). Dulong and Petit (1819) discovered the remarkable fact of the approximate constancy of the atomic heats of the elements. The apparently exceptional cases were interpreted for carbon silicon and boron by H. F. Weber (1875), and for sulphur by Regnault (1840). F. Neumann (1831) extended the law to compound bodies and Joule (1844) showed that in many cases specific heat could be treated as additively related to the component specific heats.

Among recent apparatus the invention of Bunsen's ice calorimeter (1870) deserves particular mention.

THERMODYNAMICS.

Thermodynamics, as has been stated, in a singularly fruitful way interpreted and broadened the old Leibnitzian principle of *vis viva* of 1686. Beginning with the incidental experiments of Rumford (1798) and of Davy (1799) just antedating the century, the new conception almost leaped into being when J. R. Mayer (1842, 1845)

defined and computed the mechanical equivalent of heat, and when Joule (1843, 1845, et seq.) made that series of precise and judiciously varied measurements which mark an epoch. Shortly after Helmholtz (1847), transcending the mere bounds of heat, carried the doctrine of the conservation of energy throughout the whole of physics.

Earlier in the century Carnot (1824), stimulated by the growing importance of the steam engine of Watt (1763, et seq.), which Fulton (1806) had already applied to transportation by water and which Stephenson (1829) soon after applied to transportation by land, invented the reversible thermodynamic cycle. This cycle or sequence of states of equilibrium of two bodies in mutual action is, perhaps, without a parallel in the prolific fruitfulness of its contributions to modern physics. Its continued use in fifty years of research has but sharpened its logical edge. Carnot deduced the startling doctrine of a temperature criterion for the efficiency of engines. Clapeyron (1834) then gave the geometrical method of representation universally used in thermodynamic discussions to-day, though often made more flexible by new coordinates as suggested by Gibbs (1873).

To bring the ideas of Carnot into harmony with the first law of thermodynamics it is necessary to define the value of a transformation, and this was the great work of Clausius (1850), followed very closely by Kelvin (1851) and more hypothetically by Rankine (1851). The latter's broad treatment of energetics (1855) antedates many recent discussions. As early as 1858 Kirchhoff investigated the solution of solids and of gases thermodynamically, introducing at the same time an original method of treatment.

The second law was not generally accepted without grave misgiving. Clausius, indeed, succeeded in surmounting most of the objections, even those contained in theoretically delicate problems associated with radiation. Nevertheless, the confusion raised by the invocation of Maxwell's 'demon' has never quite been calmed; and while Boltzmann (1877, 1878) refers to the second law as a case of probability, Helmholtz (1882) admits that the law is an expression of our inability to deal with the individual atom. Irreversible processes as yet lie quite beyond the pale of thermodynamics. For these the famous inequality of Clausius is the only refuge. The value of an uncompensated transformation is always positive.

The invention of mechanical systems which more or less fully conform to the second law has not been infrequent. Ideas of this nature have been put forward by Boltzmann (1866, 1872), by Clausius (1870, 1871) and more powerfully by Helmholtz (1884) in his theory of cyclic systems, which in a measure suggested the hidden mechanism at the root of Hertz's dynamics. Gibbs's (1902) elementary principles of statistical mechanics seem, however, to contain the nearest approach to a logical justification of the second law —an approach which is more than a dynamical illustration.

The applications of the first and second laws of thermodynamics are ubiquitous. As interesting instances we may mention the conception of an ideal gas and its properties; the departure of physical gases from ideality as shown in Kelvin and Joule's plug experiment (1854, 1862); the corrected temperature scale resulting on the one hand, and the possibility of the modern liquid air refrigerator of Linde and Hampson (1895) on the other. Difficulties encountered in the liquefaction of incoercible gases by Cailletet and Pictet (1877) have vanished even from the hydrogen coercions

of Olezewski (1895) and of Dewar and Travers.

Again, the broad treatment of fusion and evaporation, beginning with James Thomson's (1849) computation of the melting point of ice under pressure, Kirchhoff's (1858) treatment of sublimation, the extensive chapter of thermo-elastics set on foot by Kelvin's (1883) equation, are further examples.

To these must be added Andrews's (1869) discovery of the continuity of the liquid and the gaseous states foreshadowed by Cagniard de la Tour (1822, 1823); the deep insight into the laws of physical gases furnished by the experimental prowess of Amagat (1881, 1893, 1896), and the remarkably close approximation amounting almost to a prediction of the facts observed which is given by the great work of van der Waals (1873).

The further development of thermodynamics, remarkable for the breadth, not to say audacity, of its generalizations, was to take place in connection with chemical systems. The analytical power of the conception of a thermodynamic potential was recognized nearly at the same time by many thinkers: by Gibbs (1876), who discovered both the isothermal and the adiabatic potential; by Massieu (1877), independently in his 'functions caracteristiques'; by Helmholtz (1882), in his 'Freie Energie'; by Duhem (1886) and by Planck (1887, 1891), in their respective thermodynamic potentials. The transformation of Lagrange's doctrine of virtual displacements of indefinitely more complicated systems than those originally contemplated, in other words the introduction of a virtual thermodynamic modification in complete analogy with the virtual displacement of the 'mecanique analytique,' marked a new possibility of research of which Gibbs made the profoundest use. Unaware of this marshaling of powerful mathematical forces, van't Hoff (1886, 1888) consummated his marvelously simple application of the second law; and from interpretations of the experiments of Pfeffer (1877) and of Raoult (1883, 1887) propounded a new theory of solution, indeed a basis for chemical physics in a form at once available for experimental investigation.

The highly generalized treatment of chemical statics by Gibbs bore early fruit in its application to Deville's phenomenon of dissociation (1857), and in succession Gibbs (1878, 1879), Duhem (1886), Planck (1887), have deduced adequate equations, while the latter in case of dilute solutions gave a theoretical basis for Guldberg and Waage's law of mass action (1879). An earlier independent treatment of dissociation is due to Horstmann (1869, 1873).

In comparison with the brilliant advance of chemical statics which followed Gibbs, the progress of chemical dynamics has been less obvious; but the outlines of the subject have, nevertheless, been succinctly drawn in a profound paper by Helmholtz (1886), followed with much skill by Duhem (1894, 1896) and Natanson (1896).

KINETIC THEORY OF GASES.

The kinetic theory of gases at the outset, and as suggested by Herapath (1821), Joule (1851, 1857), Krönig (1856), virtually reaffirmed the classic treatise of Bernoulli (1738). Clausius in 1857–62 gave to the theory a modern aspect in his derivation of Boyle's law in its thermal relations, molecular velocity and of the ratio of translational to total energy. He also introduced the mean free path (1858). Closely after followed Maxwell (1860), adducing the law for the distribution of velocity among molecules, later critically and elaborately examined by Boltzmann (1868–81). Nevertheless, the difficulties relating to the partition of energy have not yet been sur-

mounted. The subject is still under vigorous discussion, as the papers of Burbury (1899) and others testify.

To Maxwell (1860, 1868) is due the specifically kinetic interpretation of viscosity, of diffusion, of heat conduction, subjects which also engaged further attention from Boltzmann (1872–87). Rigorous data for molecular velocity and mean free path have thus become available, and van der Waals (1873) added a final allowance for the size of the molecules.

Less satisfactory has been the exploration of the character of molecular force for which Maxwell, Boltzmann (1872, et seq.), Sutherland (1886, 1893) and others have put forward tentative investigations.

The intrinsic equation of fluids discovered and treated in the great paper of van der Waals (1873), though partaking of the character of a first approximation, has greatly promoted the coordination of most of the known facts. Corresponding states, the thermal coefficients, the vapor pressure relation, the minimum of pressure-volume products, and even molecular diameters are reasonably inferred by van der Waals from very simple premises. Many of the results have been tested by Amagat (1896).

The data for molecular diameter furnished by the kinetic theory as a whole, viz., the original values of Loschmidt (1865), of van der Waals (1873) and others, are of the same order of values as Kelvin's estimates (1883) from capillarity and contact electricity. Many converging lines of evidence show that an approximation to the truth has surely been reached.

RADIATION.

Our knowledge of the radiation of heat, diathermacy, thermocrosis, was promoted by the perfection which the thermopyle reached in the hands of Melloni (1835–53). These and other researches set at rest forever all questions relating to the identity of heat and light. The subject was, however, destined to attain a much higher order of precision with the invention of Langley's bolometer (1881). The survey of heat spectra, beginning with the laborious attempts of Herschel (1840), of E. Becquerel (1843, 1870), H. Becquerel (1883) and others, has thus culminated in the magnificent development shown in Langley's charts (1883, 1884, et seq.).

Kirchhoff's law (1860), to some extent anticipated by Stewart (1857, 1858), pervades the whole subject. The radiation of the black body, tentatively formulated in relation to temperature by Stefan (1879) and more rigorously by Boltzmann (1884), has furnished the savants of the Reichsanstalt with means for the development of a new pyrometry whose upper limit is not in sight.

Among curious inventions Crooke's radiometer (1874) and Bell's photophone may be cited. The adaptation of the former in case of high exhaustion to the actual measurement of Maxwell's (1873) light pressure by Lebedew (1901) and Nichols and Hull (1903) is of quite recent history.

The first estimate of the important constant of solar radiation at the earth was made by Pouillet (1838); but other pyrheliometric methods have since been devised by Langley (1884) and more recently by Ångström (1886, et seq.).

VELOCITY OF LIGHT.

Data for the velocity of light, verified by independent astronomical observations, were well known prior to the century; for Römer had worked as long ago as 1675, and Bradley in 1727. It remained to actually measure this enormous velocity in the laboratory, apparently an extraordinary feat, but accomplished simultaneously by Fizeau (1849) and by the aid of Wheatstone's revolving mirror (1834) by Fou-

cault (1849, 1850, 1862). Since that time precision has been given to this important constant by Cornu (1871, 1873, 1874), Forbes and Young (1882), Michelson (1878, et seq.) and Newcomb (1885). Foucault (1850), and more accurately Michelson (1884), determined the variation of velocity with the medium and wave length, thus assuring to the undulatory theory its ultimate triumph. Grave concern, however, still exists, inasmuch as Michelson and Morley (1886) by the most refined measurement, and differing from the older observations of Fizeau (1851, 1859), were unable to detect the optical effect of the relative motion of the atmosphere and the luminiferous ether predicted by theory.

Römer's observation may in some degree be considered as an anticipation of the principle first clearly stated by Döppler (1842), which has since become invaluable in spectroscopy. Estimates of the density of the luminiferous ether have been published, in particular by Kelvin (1854).

GEOMETRIC OPTICS.

Prior to the nineteenth century geometric optics, having been mustered before Huyghens (1690), Newton (1704), Malus (1808), Lagrange (1778, 1803) and others, had naturally attained a high order of development. It was, nevertheless, remodeled by the great paper of Gauss (1841) and was thereafter generalized step by step by Listing, Möbius (1855), and particularly by Abbe (1872), postulating that in character, the cardinal elements are independent of the physical reasons by which one region is imaged in another.

So many able thinkers like Airy (1827), Maxwell (1856, et seq.), Bessel (1840, 1841), Helmholtz (1856, 1867), Ferraris (1877, 1880) and others have contributed to the furtherance of geometric optics, that definite mention is impossible. In other cases again, profound methods like those of Hamilton (1828, et seq.), Kummer (1859), do not seem to have borne correspondingly obvious fruit. The fundamental bearing of diffraction on geometric optics was first pointed out by Airy (1838), but developed by Abbe (1873) and after him by Rayleigh (1879). An adequate theory of the rainbow, due to Airy and others, is one of its picturesque accomplishments (1838).

The so-called astronomical refraction of a medium of continuously varying index, successively treated by Bouguer (1739, 1749), Simpson (1743), Bradley (1750, 1762), owes its recent refined development to Bessel (1823, 1826, 1842), Ivory (1822, 1823, et seq.), Radau (1884) and others. Tait (1883) gave much attention to the allied treatment of mirage.

In relation to instruments the conditions of aplantism were examined by Clausius (1864), by Helmholtz (1874), by Abbe (1873, et seq.), by Hockin (1884) and others, and the apochromatic lens was introduced by Abbe (1879). The microscope is still well subserved by either the Huyghens or the Ramsden (1873) eyepiece, but the objective has undergone successive stages of improvement, beginning with Lister's discovery in 1830. Amici (1840) introduced the principle of immersion; Stephenson (1878) and Abbe (1879), homogeneous immersion; and the Abbe-Zeiss apochromatic objective (1886), the outcome of the Jena-glass experiments, marks, perhaps, the high-water mark of the art for the microscope. Steinheil (1865, 1866) introduced the guiding principle for photographic objectives. Alvan Clark carried the difficult technique of telescope lens construction to a degree of astonishing excellence.

SPECTRUM. DISPERSION.

Curiously, the acumen of Newton (1866,

1704) stopped short of the ultimate conditions of purity of spectrum. It was left to Wollaston (1802), about one hundred years later, to introduce the slit and observe the dark lines of the solar spectrum. Fraunhofer (1814, 1815, 1823) mapped them out carefully and insisted on their solar origin. Brewster (1833, 1834), who afterwards (1860) published a map of 3,000 lines, was the first to lay stress on the occurrence of absorption, believing it to be atmospheric. Forbes (1836) gave even greater definiteness to absorption by referring it to solar origin. Foucault (1849) pointed out the coincidence of the sodium lines with the D group of Fraunhofer, and discovered the reversing effect of sodium vapor. A statement of the parallelism of emission and absorption came from Ångström (1855) and with greater definiteness and ingenious experiments from Stewart (1860). Nevertheless, it was reserved to Kirchhoff and Bunsen (1860, 1861) to give the clear-cut distinctions between the continuous spectra and the characteristically fixed bright-line or dark-line spectra upon which spectrum analysis depends. Kirchhoff's law was announced in 1861 and the same year brought his map of the solar spectrum and a discussion of the chemical composition of the sun. Huggins (1864, et seq.), Ångström (1868), Thalén (1875), followed with improved observations on the distribution and wave-length of the solar lines; but the work of these and other observers was suddenly overshadowed by the marvelous possibilities of the Rowland concave grating (1882, et seq.). Rowland's maps and tables of the solar spectrum as they appeared in 1887, 1889, et seq., his summary of the elements contained in the sun (1891), each marked a definite stage of advance of the subject. Mitscherlich (1862, 1863) probably was the first to recognize the banded or channeled spectra of compound bodies. Balmer (1885) constructed a valuable equation for recognizing the distribution of single types of lines. Kayser and Runge (1887, et seq.) successfully analyzed the structure of the spectra of alkaline and other elements.

The modernized theory of the grating had been given by Rayleigh in 1874 and was extended to the concave grating by Rowland (1892, 1893) and others. A general theory of the resolving power of prismatic systems is also due to Rayleigh (1879, 1880) and another to Thollon (1881).

The work of Rowland for the visible spectrum was ably paralleled by Langley's investigations (1883, et seq.) of the infra-red, dating from the invention of the bolometer (1881). Superseding the work of earlier investigators like Fizeau and Foucault (1878) and others, Langley extended the spectrum with detailed accuracy to over eight times its visible length. The solar and the lunar spectrum, the radiations of incandescent and of hot bodies, were all specified absolutely and with precision. With artificial spectra Rubens (1892, 1899) has since gone further, reaching the longest heat waves known.

A similarly remarkable extension was added for the ultra-violet by Schumann (1890, 1892), contending successfully with the gradually increasing opacity of all known media.

Experimentally the suggestion of the spectroheliograph by Lockyer (1868) and by Janssen (1868) and its brilliant achievement by Hale (1892) promise notable additions to our knowledge of solar activity.

Finally, the refractions of absorbing media have been of great importance in their bearing on theory. The peculiarities of metallic reflection were announced from his earlier experiments (1811) by Arago in 1817 and more fully investigated by Brewster (1815, 1830, 1831). F. Neumann

(1832) and MacCullagh (1837) gave sharper statements to these phenomena. Equations were advanced by Cauchy (1836, et seq.) for isotropic bodies, and later with greater detail by Rayleigh (1872), Ketteler (1875, et seq.), Drude (1887, et seq.) and others. Jamin (1847, 1848) devised the first experiments of requisite precision and found them in close agreement with Cauchy's theory. Kundt (1888) more recently investigated the refraction of metallic prisms.

Anomalous dispersion was discovered by Christiansen in 1870, and studied by Kundt (1871, et seq.). Sellmeyer's (1872) powerful and flexible theory of dispersion was extended to include absorption effects by Helmholtz (1874), with greater detail by Ketteler (1879, et seq.), and from a different point of view by Kelvin (1885). The electromagnetic theory lends itself particularly well to the same phenomena, and Kolázek (1887, 1888), Goldhammer (1892), Helmholtz (1892), Drude (1893) and others instanced its adaptation with success.

PHOTOMETRY, FLUORESCENCE, PHOTOCHEMISTRY.

The cosine law of Lambert (1760) has since been interpreted in a way satisfying modern requirements by Fourier (1817, 1824) and by Lommel (1880). Among new resources for the experimentalist the spectrophotometer, the Lummer-Brodhun photometer (1889) and Rood's flicker photometer (1893, 1899) should be mentioned.

Fluorescence, though ingeniously treated by Herschel (1845, 1853) and Brewster (1846, et seq.), was virtually created in its philosophical aspects by Stokes in his great papers (1852, et seq.) on the subject. In recent years Lommel (1877) made noteworthy contributions. Phosphorescence has engaged the attention of E. Becquerel (1859), among others.

The laws of photochemistry are in large measure due to Bunsen and Roscoe (1857, 1862). The practical development of photography from its beginnings with Daguerre (1829, 1838) and Niépce and Fox-Talbot (1839), to its final improvement by Maddox (1871) with the introduction of the dry plate, is familiar to all. Vogel's (1873) discovery of appropriate sensitizers for different colors has added new resources to the already invaluable application of photography to spectroscopy.

INTERFERENCE.

The colors of thin plates treated successively by Boyle (1663), Hooke (1665), and more particularly by Newton (1672, 'Optiks,' 1704), became in the hands of Young (1802) the means of framing an adequate theory of light. Young also discovered the colors of mixed plates and was cognizant of loss of half a wave-length on reflection from the denser medium. Fresnel (1815) gave an independent explanation of Newton's colors in terms of interference, devising for further evidence, his double mirrors (1816), his biprism (1819) and eventually the triple mirror (1820). Billet's plates and split lens (1858) belong to the same classical order, as do also Lloyd's (1837) and Haidinger's (1849) interferences. Brewster's (1817) observation of interference in case of thick plates culminated in the hands of Jamin (1856, 1857) in the useful interferometer. The scope of this apparatus was immensely advanced by the famous device of Michelson (1881, 1882), which has now become a fundamental instrument of research. Michelson's determination of the length of the meter in terms of the wave-length of light with astounding accuracy is a mere example of its accomplishments.

Wiener (1890) in his discovery of the stationary light wave introduced an entirely new interference phenomenon. The method was successfully applied to color

photography by Lippmann (1891, 1892), showing that the electric and not the magnetic vector is photographically active.

The theory of interferences from a broader point of view, and including the occurrence of multiple reflections, was successively perfected by Poisson (1823), Fresnel (1823), Airy (1831). It has recently been further advanced by Feussner (1880, et seq.), Sohncke and Wangerin (1881, 1883), Rayleigh (1889) and others. The interferences along a caustic were treated by Airy (1836), but the endeavor to reconstruct geometric optics on a diffraction basis has as yet only succeeded in certain important instances, as already mentioned.

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(To be continued.)

SCIENTIFIC BOOKS.

Species and Varieties, their Origin by Mutation. By HUGO DE VRIES; edited by DANIEL TREMBLY MACDOUGAL. Chicago, The Open Court Publishing Co.

De Vries's great work 'Die Mutationstheorie' marks an epoch in biology as truly as did Darwin's 'Origin of Species.' The revolution that it is working is less complete, perhaps, because there has remained no such important doctrine as that of continuity to be established. But there was need of a revolution in our method of attacking the problems of evolution. Ever since Darwin's time most biologists have been content to *discuss* and argue on the *modus operandi* of evolution. The data collected by Darwin have been quoted like scriptural texts to prove the truth of the most opposed doctrines. We have seen biologists divided into opposing camps in defense of various isms, but of the collection of new data and, above all, of experimentation we have had little. The great service of de Vries's work is that, being founded on experimentation, it challenges to experimentation as the only judge of its merits. It will attain its highest usefulness only if it creates a widespread stimulus to the experimental investigation of evolution.

To be read, nowadays, a book must be brief. Much of the success of the 'Origin of Species' was due to the mass of material which was left out. The very bulkiness of de Vries's original work must prevent its being read as widely as it deserves. There was needed a briefer presentation of de Vries's views and one in English, and this need has fortunately been filled by de Vries himself in the work now under review. This book should be read with care by every biologist; the brief synopsis of its contents which alone is possible here can in no wise make such a reading unnecessary.

After an introductory chapter, the fundamental distinction between elementary species and varieties is discussed. Elementary species are forms that are distinct in several characters from their close allies and breed true. They are thought to have arisen from their parent form in a progressive way, *i. e.*, by the addition of a new characteristic. In this they are distinguished from retrograde varieties on the one hand and mere fluctuations of characters on the other.

The subject of retrograde varieties (constituting the third section of the book) assumes great importance in de Vries's system. They are varieties in the new (restricted) sense. They differ from the parent species usually in the absence of some single character; for example, the white flower variety of a plant or the hairless form of an ordinarily hirsute species. The eliminated characters are of a few, definite, constantly recurring kinds. In this respect varieties differ from elementary species whose differential characters are most varied. Moreover, varieties are subordinate to some elementary species, whereas elementary species are coordinate.

In self-fertilization varieties behave in a characteristic way. They are frequently constant. Even varieties that are intermediate between the parent species and other varieties may be as stable as the latter. Indeed, we know that certain garden varieties have been bred in their present form for two or three centuries. Such varieties may, however,

sometimes even, though rarely, revert to the ancestral form. When varieties are crossed with the ancestral species the characters of the species are dominant in the hybrids, so that the hybrid appears like the species. De Vries finds, accordingly, that many cases of apparent reversion, or atavism, in the offspring of a variety of plant are due to the accidental cross pollination with the ancestral species; the 'reverted' forms are really hybrids. This phenomenon is called by de Vries 'vicinism'—the false atavism being due to the presence of the species in the vicinity. In addition to this false atavism there can be distinguished a true one. For, although in retrograde varieties the quality that has dropped out *may* become wholly lost, it may, on the other hand, be merely latent and may reappear, usually suddenly, in some individual. At this point de Vries introduces the idea of positive varieties as opposed to negative ones. These are characterized by the addition of a quality which had been latent. (The addition of a *new* quality is, it will be recalled, in de Vries's scheme, the origin of an elementary species. But will it not be often impossible to say whether a new appearing quality is truly new or old?)

In cross-breeding the contrast between varieties and species still holds. When a new species, which is characterized by a new quality, is bred to the parent form, its germ cell bears a unit-character of which the parent species offers no representative with which it may be mated in the conjugation of the sex cells. This sort of cross is called a 'unisexual' cross (unbalanced or unsymmetrical cross would have been less ambiguous). Varieties, on the other hand, have the same characters as the parent species, only one of them is latent. This latency of the characteristic does not prevent its union with the corresponding patent characteristic of the parent species. The offspring of a unisexual cross are apt to have the various characters of one or the other parent intact, fully developed, side by side. These first generation hybrids are all of the same type; in general aspect they are intermediate between the two species and this intermediacy persists when the hybrids are inbred. In the so-called bisexual crosses, on the other hand, the first hybrid generation is said to resemble the parent species. When such hybrids are inbred a segregation of the various characters in different individuals appears. This segregation occurs in accordance with Mendel's law, and that law is applicable only to bisexual (balanced) crosses.

The fourth section treats of 'ever-sporting' varieties and is the most novel and suggestive in the book. It is essentially experimental, yet one feels that the results gained are tentative. Ever-sporting varieties are defined as 'forms that are regularly propagated by seed, are of pure and not hybrid origin, but which sport in nearly every generation.' Of such varieties two types are recognized: 'poor' races or 'half' races, and 'rich' races or 'middle' races. In the former a sport transmits its peculiarity to only a small percentage—one per cent. to three per cent.—of its progeny. In the latter a transmission to twenty-five per cent. to fifty per cent. of the offspring may occur. However, the two sorts of races are not so sharply differentiated as these figures would indicate, but naming the extremes will accentuate the fact of variability in the transmissibility of sports, in plants. The same thing is found in man. Polydactylism is in some families strongly transmitted, in others less strongly, in others almost not at all. De Vries was unable to establish a race of five-leaved crimson clover, whereas he quickly got a race of five-leaved red clover. Monstrosities behave like other variations, showing both poor and rich races. In the further development of the subject de Vries is led to explain cases of functional adaptation in plants on the ground that two types are always present in species showing these adaptations, and that 'during their juvenile stage a decision is taken in one direction or the other.' He even goes so far as to ascribe the difference in height of some plants, according as they occur in rich or poor soil to a dimorphic tendency toward, one or the other stature. This conclusion requires statistical proof before it will be generally accepted.

The fifth section is headed 'Mutations' and is, we think, the most powerful in the book. The author tells in two chapters of his early attempts to produce races having certain abnormalities—a toad-flax with peloric flowers (*i. e.,* having radial instead of bilateral symmetry) and a double daisy out of a single one. He tells the story of his discovery of the mutating evening primrose and the way it produced new varieties and species in his garden. These new forms, *when self-fertilized,* reproduced themselves in a high percentage of cases. His experience with these mutating plants led him to formulate seven laws as follows: (1) New elementary species appear suddenly, without intermediate steps; (2) they spring laterally from the main stem (not replacing it); (3) they attain their full constancy at once; (4) some of the new strains are elementary species, others are to be regarded as varieties; (5) the same new species are produced in a large number of individuals; (6) mutations undergo fluctuating variation, but the latter is not evolution and (7) mutations take place in nearly all directions.

An apparent difficulty to accepting mutations as the sole source of new species is their rarity. An investigation of the literature, however, convinces de Vries that there is a number of records of species and varieties arising by mutation and in horticulture mutating strains play an important part. In the lecture on systematic atavism the author shows that many mutations are repetitions of an ancestral condition that has lain latent (by the author's previous definition the coming into activity of latent characters is the production of positive varieties); and in the illuminating lecture on taxonomic anomalies he cites numerous wild species that are distinguished by characteristics that appear to be sports and have probably arisen *per saltum.*

In his lecture on periodic mutation de Vries sets forth the theory that in species periods of rest or stability alternate with periods of mutation. If ever we can produce the mutating period at will then we can hasten the course of evolution. De Vries concludes that, despite the long periods elapsing between successive mutation periods in any species the theory demands less time than that of selection of infinitesimal variations and so fits in better with the newer conclusions of physicists who are tending to shorten the probable age of the earth.

The final section of the book is devoted to 'Fluctuations.' It contains a keen argument against the importance for evolution of the selection of minute variations. After discussing the general laws of fluctuation as enunciated by Quetelet and Galton (and warning biologists against the use of ultra-biometric methods whose biological significance is uncertain) de Vries states that fluctuations take place in two directions only; they are either plus or minus. Mutations, on the other hand, are going on in 'all directions.' The cause of fluctuating variability is variation in nourishment. (This can hardly be true of the rays of *Pecten,* whose number is independent of size and is fixed a few hours after hatching.)

Although new species may not be produced by the selection of fluctuating characters, it is recognized that such selection may be of great importance in improving the quality of any characteristic; particularly when the improvement can be propagated by asexual methods as (in plants) by cuttings. The true method for the breeder of perennials is indeed to combine the preservation of sports, the selection of the best variants, and hybridizing. In the case of annuals it will be found that improvement by selection is impossible beyond a certain point and constant attention is needed to maintain any advance made. Indeed, it is just this difficulty of maintaining an advantage that rules out selection inside the species as of importance in nature.

The foregoing is a summary of de Vries's argument. Its force is sufficiently proved by the widespread acceptation it has gained and by the stimulus it has already given to experimental work.

As to the correctness of de Vries's conclusions the future alone can give the final decision—doubtless in some points of detail they will have to be modified. The main truth of the vast importance of mutations in the origin of species can no longer be ques-

tioned. The reviewer is convinced that as good an argument might be made from the zoological side as de Vries has made from the botanical. Undoubtedly many, if not most, of the characteristics of the races of domesticated animals and probably of feral species have arisen by mutation. Take, for example, poultry. The qualities that differentiate them are of the order of mutations—feathered feet, rose comb, elongated tail, taillessness, silky feathers, frizzled feathers, cerebral hernia, polydactyl feet, albinism and many others. All the evidence we have goes to show that these have arisen suddenly, and none of them is halved in cross-breeding. Various wild birds show these same qualities and we must conclude that in wild species also these characteristics have arisen suddenly. Thus we have various wild birds with crests like the Polish fowl (*i. e.*, the umbrella bird, *Cephalopterus*); there are 'cross bills,' showing an abnormality not uncommon among poultry; there is a syndactyl species of monkey; and there are hairless species of mammals. The long tailed condition of certain Japanese fowl is exactly duplicated in the widow-bird (*Chera*). There is hardly a sport not actually prejudicial to the well being of animals which is not realized in some species.

On the other hand, it is certainly true for zoology that many species are based chiefly on 'more' or 'less' of a certain character than an allied species. Further, since animals have a more definite form than plants, and one less modified by variations in environment the fact of geographic variation is a striking one. Now in geographic variation the forms of adjacent localities are distinguished by differences of the order of fluctuating variants; the mode being different in each place; yet the differences between remote localities are of the order of mutations. Geographic variation has been repeatedly observed among birds, fishes, insects and mollusca. It is, of course, possible that the absence of discontinuity in the species may be due to hybridization with blending of characteristics, but blending of characteristics is not so common among hybrids as to justify, offhand, such an explanation. That there is evidence of evolution without mutation can not be denied.

The distinction between species and varieties is clearly expressed by de Vries, but it is doubtful if it will be of wide service because of the difficulty of distinguishing between a 'new' character and an 'atavism.' De Vries admits (p. 564) 'It is often difficult to decide whether a given form belongs to one or another of these two groups.' We look with interest to the experimental testing of de Vries's distinction in animals.

As to the literary qualities of the book, one has first to praise the general method of exposition. It is quite a model. Apart from an occasional non-idiomatic phrase or inapt word the diction is good; but much of this success is of course due to Dr. MacDougal's careful editing. It is unfortunate that the proof reading has been rather carelessly done and that commas are so atrociously misplaced as often to obscure the sense. Otherwise the publishers have done their part well. The broad margins leave plenty of room for the reader's remarks and memoranda which so suggestive a book tends to call forth in great number.

De Vries's book is one to read and reread and then to act upon. We would not wish it less clear cut in its presentation, for then it might merely amuse. As it is it gives a stimulus to the experimental testing of his broad generalizations and iconoclastic conclusions.

C. B. Davenport.

Theoretical Chemistry from the Standpoint of Avogadra's Rule and Thermodynamics. By Professor Walter Nernst, Ph.D., of the University of Göttingen. Revised in accordance with the Fourth German edition. Translated into English by Robert A. Lehfeldt. London and New York, Macmillan and Company, Limited. 1904. Pp. 771.

The appearance of the fourth edition of this valuable treatise will be welcomed by all advanced workers in the field of physical chemistry. The general character of this work is too well known to call for special comment. It is distinctively an advanced work, and adapted only to those who have already a good

general knowledge of the elements of physical chemistry.

It is an unfortunate beginner into whose innocent hands such a book is placed, and this leads to a few words in reference to this phase of the subject of teaching science. It is a fair question to ask whether the error is not frequently made by over-zealous teachers, of placing works that are too advanced in the hands of their pupils. The reviewer recalls having heard a teacher of organic chemistry announce rather boastfully that his class of beginners in organic chemistry was given Richter's book, and made to master its entire contents, *i. e.*, master it from the standpoint of examination.

This was only a little more unfortunate than the placing of Ostwald's inorganic chemistry in the possession of those who were just beginning the study of general chemistry. The result in both cases would be the same, of course, inevitable failure.

A similar result would be secured by beginning the study of physical chemistry with the book under review.

A few words must be added in reference to the English translation. The translation of the first edition of this book into English, as is well-known, left much to be desired. It is not too much to say that it was inadequate and unsatisfactory. It was with some feeling of relief that the new translation was greeted. It seemed that this admirable book would now be rendered into satisfactory English. It is deeply to be regretted that the examination of the translation showed that it did not fulfil this expectation. The translator states in his own preface that 'The bulk of the old text, however, remains as it was.' This is most disappointing.

If we examine the translation page by page, we shall find so many glaring violations of good, clear, idiomatic English that we soon become disheartened. These reasons alone lead us to advise those who would work through the book to use the original German; and this raises the further question, whether it is even desirable to translate such an advanced work from the German into English? Any one who can use this book with profit can, or at least should be able to read German with ease. Is it not catering to a wrong principle to make such a work accessible to those who *must master German,* if they would follow scientific thought to any depth, to say nothing of making contributions to scientific knowledge? Every one will answer this question for himself.

In criticizing the translation adversely, it must, however, not be forgotten that to secure even this result involved an enormous amount of drudgery on the part of the translator, which will be appreciated by every one who has translated even a small book.

HARRY C. JONES.

SCIENTIFIC JOURNALS AND ARTICLES.

THE contents of *The American Journal of Anatomy* for September are as follows:

FRANKLIN P. MALL: 'On the Angle of the Elbow.'

E. LINDON MELLUS: 'A Study of the Location and Arrangement of the Giant Cells in the Cortex of the Right Hemisphere of the Bonnet Monkey (*Macacus Sinicus*).'

SUSANNA PHELPS GAGE: 'A Three Weeks' Human Embryo, with Especial Reference to the Brain and the Nephric System.'

WILLIAM SNOW MILLER: 'The Blood and Lymph Vessels of the Lung of *Necturus maculatus*.'

FRANK A. STROMSTEN: 'A Contribution to the Anatomy and Development of the Venous System of *Chelonia*.'

The Journal of Nervous and Mental Diseases for August opens with a study of clinical and post-mortem records bearing on the operability of brain tumors and their symptomatology, by Drs. G. L. Walton and W. E. Paul. Following this, Dr. S. D. Ludlum reports an experimental study on the regeneration of the peripheral nerves; and the presidential address delivered by Dr. Spiller before the American Neurological Association, on the importance in clinical diagnosis of paralysis of associated movements of the eyeballs, especially of upward and downward movements, is concluded in this number. It is extensively illustrated and elucidated by tables. The leading article in the September issue is by

Dr. Theodore A. Hoch, on a case of acute anterior poliomyelitis in a youth, sixteen years old, who died in thirteen weeks after the onset of the disease. The clinical and post-mortem records of the case are given, and the microscopical examination is extensively illustrated. The article is to be continued. Following this, Dr. Paul Masoin, physician at the colony of Gheel, Belgium, reports and briefly discusses five cases of epileptiform attacks occurring in the course of dementia præcox among patients at the colony, comparing them with the other motor exteriorations of hebephreno catatonic subjects. Dr. Guy Hinsdale next presents the history of a remarkable case of paraplegia from fracture of the first, second and third dorsal vertebræ. The patient suffered seven other fractures in the accident, an explosion. A laminectomy was performed, removing the arches of the first, second, third and a part of the fourth dorsal vertebræ. Three years after the accident the patient is able to turn herself in bed, and to walk with assistance. Dr. M. A. Bliss reports a case of small round cell sarcoma of the spinal column, and Dr. G. L. Walton one of family atrophy of the peroneal type.

SPECIAL ARTICLES.

SKULL AND SKELETON OF THE SAUROPODOUS DINOSAURS, MOROSAURUS AND BRONTOSAURUS.

1. *Skull of Morosaurus.*

ONE of the most fortunate discoveries resulting from the American Museum excavations in the Bone Cabin Quarry deposits, in the Wyoming Jurassic, was the skull of *Morosaurus.* Hitherto our knowledge of the skull of the Sauropoda has been limited to the skull of *Diplodocus* and the posterior portion of the cranium of one specimen of *Morosaurus,* both described by Marsh.

The present specimen (Amer. Mus., No. 467) was traced by Dr. W. D. Matthew from a series of crushed cervical vertebræ. It was found in an extremely crushed condition and was restored with great skill and care by Mr. Adam Hermann, the preparator of the museum. In the region of the occiput some aid was gained from the specimen described by Marsh and from the posterior portion of another cranium also found in the Bone Cabin Quarry.

All three specimens exhibit a well-defined *parietal foramen* at the junction of the parietals, frontals and supraoccipitals. This foramen is smoothly lined with bone and leads directly down into the cerebral cavity. It is thus highly probable that it lodged a large pineal eye, an organ the existence of which was left problematical by Marsh.[1] In Marsh's drawing the parietal opening is indicated rather as a fontanelle than as a foramen.

The skull of *Morosaurus* differs from that of *Diplodocus* principally in the highly convex forehead or antorbital region, which is undoubtedly correlated with the difference in character of the great cropping teeth, which contrast widely with the slender, pencil-like teeth of *Diplodocus.* This skull shows these teeth in different stages of wear and of shedding or succession. Above, there are four premaxillary and eight maxillary teeth, decreasing in size as they extend toward the back of the jaw. From twelve to thirteen mandibular teeth are preserved. The deep, massive proportions of the premaxillaries, maxillaries and mandibular rami are also mechanically correlated with the insertion and powerful functions of these large teeth. It is evident, however, that the animal had no power of masticating its food, and that these anterior teeth served simply for prehensile purposes.

The anterior narial openings are very large and face forward and obliquely upward, rather than more directly upward, as in *Diplodocus.* The antorbital openings are correspondingly reduced. As restored, the orbits are enormous, but there is considerable deficiency of bone in the surrounding parts, so that the contours are not quite certain. From the superior aspect of the skull it is evident that both frontals and nasals were much longer than in *Diplodocus,* the latter bones sending forward median

[1] "There is no true pineal foramen, but in the skull here figured (Pl. II.) there is the small unossified tract mentioned above. In one specimen of *Morosaurus* a similar opening has been observed, but in other Sauropoda the parietal bones, even if thin, are complete."

bars uniting with the slender premaxillary processes. A striking feature is the large parietal foramen opening directly into the brain case, as above described. It is noteworthy that the occiput or back part of the skull has practically the same composition as that of the carnivorous dinosaurs, namely: (1) supraoccipitals bounding the parietal foramen posteriorly (this foramen is, however, absent in the carnivorous dinosaurs); (2) lateral parietal plates which hardly enter into the top of the cranial roof except to bound the parietal foramina at the sides; (3) the squamosals forming together with the paroccipital processes the infralateral portions of the occiput; (4) occipital condyles composed exclusively of the basioccipitals.

Correlated with the muscular insertions for the motions of the powerful neck we find two very powerful processes extending down from the basisphenoidal region, presenting a wide contrast to the comparatively slender processes observed in *Diplodocus*. The quadrates and pterygoids have substantially the same shape as in *Diplodocus;* the other bones of palate are not preserved. Of the bones of the jaw the dentaries, coronoids, articulars and angulars are well preserved, as shown in the drawing. The coronoids have a considerable upward extension, but nothing to compare with that seen in the Predentata since it is not necessary to provide for the insertion of muscles of mastication.

It is this skull which was mainly used in the mounted skeleton of *Brontosaurus* in the museum; only the anterior part of the skull of this animal being known.

2. *Mounted Skeleton of Brontosaurus.*

The mounting of *Brontosaurus* has occupied the museum staff more or less continuously since the discovery of the skeleton by Mr. Granger and Mr. Grant, of the American Museum expedition, in 1897. In 1898 and 1899 the excavation was completed, and a little more than two thirds of the entire skeleton was recovered. The chief missing parts are the skull, the three anterior cervicals, the fore limbs of both sides from the shoulder down, the upper portions of the sacrum, the hind limb of one side, and the terminal portion of the tail. The restoration of the skull is largely conjectural from that of *Morosaurus* above described, and the missing parts of the limbs are restored from the famous specimen in the Yale Museum, the type of Marsh's *Brontosaurus excelsus*. The terminal portion of the tail is completed from another individual in the American Museum of Natural History.

The special features of the skeleton are its large size, the absence of crushing of the bones, and the completeness of the ribs. The mounting represents not only prolonged work of difficult restoration under the supervision of the head preparator, Mr. Hermann, but very careful anatomical studies, in which Messrs. Granger, Matthew and Gidley materially assisted the writer. Messrs. Granger and Matthew especially made a complete restoration of the muscles of the shoulder girdle and fore limb prior to the placing of these elements, which was an extremely difficult matter. The manus represents the single-clawed condition, resulting from comparison with the feet of many Sauropoda. The chief measurements of the skeleton are:

	Ft.	In.
Length over all, from head to tip of tail	66	8
Length of vertebral column	64	4
Length of neck	16	10
Length of tail	31	4
Length of longest rib	6	9
Length of hind limb including foot	10	7
Length of fore limb including foot	8	6
Depth of body from lower end of pubis to top of posterior dorsal spine	8	7
Length of head as restored	2	4

It is interesting to compare these measurements with those of a fully grown 'sulphur bottom' whale, carefully measured by Mr. F. A. Lucas, and reproduced at the St. Louis Exposition. This animal, a male, measured 74 feet, 8 inches, from the notch of the flukes to the tip of the nose. The approximate weight of the bones was 17,920 pounds. The entire animal was estimated at not far from 63 tons. We observe that while the body of the whale

is longer than that of *Brontosaurus*, the absence of limbs in the whale would reduce the water displacement and weight.

Several new features are brought out in relation to the proportions of *Brontosaurus*. While a number of terminal vertebræ are undoubtedly missing, the tail is less elongate and massive than was supposed by the writer at one time. There is no evidence that it served for the support of the body, nor was the fin development for propulsion in water so great as in *Diplodocus*. A second point of interest is that the sacrum, while the center for motion, was not certainly the highest point in the body, as at one time supposed by the writer. The center of the vertebræ arch upward in front of the sacrum, and while the neural spines rapidly subside, the highest point appears to have been about the middle of the back; unless, indeed, the fore limbs were very much more flexed than appear in the present mount.

There is still room for wide differences of opinion as regards the habits and means of locomotion of these gigantic animals. Some hold the opinion that the limbs were far more flexed at the knee and elbow than they are in the present mount. that on land at least the animal had rather the attitude of the alligator, and that only while submerged beneath the water were the limbs straightened for the purposes of walking along the bottom, the claws serving to keep the feet from slipping in the mud.

H. F. O.

THE DRUMMING OF THE DRUM-FISHES (SCIÆNIDÆ).

It is rather remarkable that so common a function as the drumming of fishes should have remained so long misunderstood; that so much speculation should have been indulged in regarding a phenomenon so easily investigated in most parts of the world; and that a conspicuous specialized drumming muscle should have been either overlooked or ignored by ichthyologists.

For several years, as opportunity was afforded, I have been studying the peculiar drumming sounds made by those fishes in which this function is so strikingly developed that it has determined the family name, the inquiries being in continuation of some observations and experiments on the squeteague (*Cynoscion regalis*) carried on by Professor R. W. Tower, at Woods Hole, in 1901 and 1902, and noted by me in the Report of the U. S. Fish Commissioner for 1902 (page 137).

The diverse notions prevailing among modern writers on fishes may be seen from the following quotations from a few standard works.

Günther, in 'An Introduction to the Study of Fishes' (1880), makes only a single reference to drumming, and that a highly edifying one in connection with *Pogonias cromis:*

> These drumming sounds are frequently noticed by persons in vessels lying at anchor on the coasts of the United States. It is still a matter of uncertainty by what means the drum produces the sounds. Some naturalists believe that it is caused by the clapping together of the pharyngeal teeth, which are very large molar teeth. However, if it be true that the sounds are accompanied by a tremulous motion of the vessel, it seems more probable that they are produced by the fishes beating their tails against the bottom of the vessel in order to get rid of the parasites with which that part of their body is infested.

Jordan and Evermann, in their admirable 'American Food and Game Fishes' (1902), reassert what was stated in their 'Fishes of North and Middle America' (1898), namely, that the peculiar noise is 'supposed to be produced by forcing air from the air-bladder into one of the lateral horns.'

Boulenger, in the section on fishes in volume VII. of the Cambridge Natural History[1] (1904), discusses 'sound-producing organs' at some length, but appears to be unaware of the special mechanism existing in the drum-fishes. He cites several ways in which sounds are produced through the agency of muscles connected with the air-bladder, and copies from Sörensen[2] a diagram of the air-bladder and 'musculo-tendinous extensions from muscles of the body-wall' of a croaker (*Micropogon*

[1] Reviewed by Dr. Theodore Gill in SCIENCE, April 28, 1905.

[2] *Journal of Anatomy and Physiology*, Vol. XXIX., 1895.

undulatus) as an example of fishes in which 'the air-bladder, without possessing special muscles of its own, may, nevertheless, be partially invested by tendinous, or partly muscular and partly tendinous, extensions from the muscles of the body-wall.'

In the latest and best general work on ichthyology, Jordan's 'Guide to the Study of Fishes' (1905), this subject is but incidentally touched on, the principal reference being that 'the grunting noise made by most of the Sciænidæ in the water is at least connected with the large and divided air-bladder.'

The most satisfactory account of the drumming function is that of Sörensen in his paper 'Om Lydorganer hos Fiske' (Copenhagen, 1884), the essential parts of which in the present connection are restated in the article cited by Boulenger. Sörensen acknowledges, however, that he had examined only a single dead specimen of a single sciænid species (*Micropogon undulatus*), and it is not clear from his description that he recognized in the muscle in relation with the air-bladder a distinct organ rather than simply an offshoot of one of the abdominal muscles. It is also doubtful whether Dufossé (*Annales des Sciences Naturelles*, XIX.–XX., 1874), whom Sörensen quotes with approval, correctly interpreted the cause of this phenomenon in the drums, as this extract from Sörensen's paper will show (italics mine):

> By means of dissections [of *Sciœna aquila*] Dufossé has proved that tones can be produced by the activity of *most of the muscles*, which, coated with aponeuroses, are in immediate contact with the diverticula of the air-bladder, but that the most frequent and most intense tones are produced by the activity of those muscles, which, completely naked, are placed around the long branches of the largest diverticula. The tones may be of different pitch, in perfect accordance with their being formed in different places (and *under the influence of different muscles*).

The drumming act has been more thoroughly studied in the squeteague than in any other sciænid species; and the facts regarding it, as determined by Professor Tower, may here be repeated substantially as stated by me in 1902 (*l. c.*), but in somewhat greater detail:

1. There is in the squeteague a special drumming muscle, lying between the abdominal muscles and the peritoneum and extending the entire length of the abdomen on either side of the median line, the muscles of the two sides being united dorsally by a strong aponeurosis. The muscle is of a decided red color, in sharp contrast to the pale muscles of the abdominal parietes, and the fibers are very short, running at right angles to the long axis of the muscle.

2. The muscle, with the aponeurosis, is in close relation with the large air-bladder, and by its rapid contractions produces a drumming sound, with the aid of the tense air-bladder, which acts as a resonator. Experimentally, the removal of the air-bladder or the section of the nerves supplying the muscle abolishes the sound; if a removed air-bladder is restored to its place the drumming is resumed; and the substitution for a removed air-bladder of any hollow, thin-walled vessel of suitable size permits the resumption of drumming when the special muscle is stimulated.

3. The muscle exists only in the males, and only the males are able to make a drumming sound.

It is probable the drumming mechanism and function as existing in the squeteagues are typical of a majority of the genera of Sciænidæ; but there are some interesting variations in the limited number of genera which I have been able to examine in the field and laboratory. Thus in the croaker (*Micropogon undulatus*) the special drumming muscle is present in both male and female, and both sexes make the drumming sound; while in the so-called king-fishes or whitings (*Menticirrhus*) the drumming muscle and air-bladder are absent in both sexes and no drumming sounds are made. The seven commonest genera of drum-fishes found along the Atlantic coast may be thus classified with reference to the drumming function:

i. Drumming muscle present in both male and female, and drumming sound made by both sexes .... *Micropogon.*

ii. Drumming muscle present only in male, and drumming sound produced only by the male. *Pogonias, Sciœnops, Cynoscion, Leiostomus, Bairdiella.*

iii. Drumming muscle absent in both male and female, and no drumming sound produced by either sex .... *Menticirrhus.*

It has been observed in *Pogonias* and other genera that the drumming sounds are heard most frequently during the spawning season; and it is evident that this function is primarily sexual. Coexistent with the ability to make sounds there should be the ability to appreciate them; and Dr. George H. Parker's recent study of the squeteague ear, at the Woods Hole laboratory of the Bureau of Fisheries, has shown in that species a well-developed sound-perceiving organ. It is a suggestive fact that in the Sciænidæ the otoliths are exceptionally large; and as a meager contribution to this interesting subject I may mention that in *Menticirrhus* (in which no drumming sounds are produced) the otoliths are relatively smaller than in any of the other genera that have been examined.

HUGH M. SMITH.

BUREAU OF FISHERIES,
WASHINGTON, D. C.

PETER ARTEDI.

ON March tenth of this year occurred the bicentenary of the birth of Artedi, distinguished Swedish naturalist, founder of modern systematic ichthyology, friend and preceptor of Linnæus, and coworker with the latter in various departments of natural history. Prematurely cut short in his career, he left an imperishable legacy to science in his own writings, and in so far as he helped stimulate the activity of his more famous fellow countryman. It is little wonder that Artedi's name should be held in pious regard by nearly all students of his favorite science, and that the two-hundredth anniversary of his birth should have been commemorated by some tribute of homage.

On behalf of the Swedish Royal Academy of Science, a biographical sketch of Artedi, with an appreciation of his service as an investigator in biological science, was prepared by Professor Einar Lönnberg, of Upsala University, and has been translated into English by W. E. Harlock.[1] This is a plain and straightforward narrative, interesting and instructive, sympathetic but without pretense of eulogy; and though the mutual dependence of the two twin-stars of Swedish natural science is clearly set forth, there is no attempt to add luster to the one at the expense of the other. Brother students and pioneers, their relations are as pleasing to contemplate as those between Darwin and Wallace, and such comparisons as are drawn between them in this bicentenary memoir have every appearance of being true and fair-minded.

Many details of Artedi's life, his difficulties, devotion, temperament, methods of work and other matters not generally known are told in this brief biography. Those interested are commended to read the sketch itself. Only a word may be said here in appreciation of his ichthyological writings. The high regard professed for them by Dr. Günther and President Jordan in their popular works on 'Fishes' is well known, and it is rare that one meets with less favorable comments. Dr. Gill, however, is inclined to take a somewhat depreciatory view, since he remarks in SCIENCE (XXII., p. 140): "I can by no means assent to the estimate as to 'the extremely valuable historical and bibliographical works of Artedi.' * * * " We hope that our learned critic will not take it amiss if we set over against his opinion the following extracts from the biography now in our hands:

> The fourth part of Artedi's 'Ichthyologia' is called 'Synonymia Nomium Piscium.' In it, as Günther truly remarks, references to all previous authors are arranged for every species, very much in the same manner as is adopted in the systematic works of the present day; these references and quotations are inserted under the diagnosis of each several species, entailing for the author a vast amount of labor, as Linnæus had occasion to find out when editing the work, for Artedi had not quite finished off the copying of them in. The laboriousness of the task becomes patent to all, when it is known that Artedi was so conscientious that he went back even to the ancient Greek and Latin writers, and endeavored to eluci-

[1] 'Peter Artedi: A Bicentenary Memoir,' by A. J. E. Lönnberg. Upsala and Stockholm, 1905, pp. 44.

date what they may have meant by their varied and diverse nomenclature and by other statements concerning certain fishes. More than 150 forms have been dealt with in that thorough-going style, the quotations under each one often exceeding a score in number. Artedi's 'Synonymia,' consequently, bears witness in its author not only to exceptional capacity for arduous toil and a deep and wide reading, but also to a rare degree of critical acumen and exactitude. For that reason the work forms a practically indispensable key to the earliest ichthyological literature (p. 40).

C. R. EASTMAN.

DECLARATION OF THE NATIONAL EDUCATIONAL ASSOCIATION AT THE ASBURY PARK MEETING.

THE National Educational Association, now holding its forty-fourth annual convention in Asbury Park and Ocean Grove, and representing the teachers and friends of education throughout the country, makes the following declaration of principles:

1. The Bureau of Education continues to render invaluable service to the nation. It is the judgment of the association that the powers of the bureau should be enlarged and that liberal appropriations should be made to it by Congress in order to enable it to widen its usefulness.

2. The National Educational Association notes with approval that the qualifications demanded of teachers in the public schools, and especially in city public schools, are increasing annually, and particularly that in many localities special preparation is demanded of teachers. The idea that any one with a fair education can teach school is gradually giving way to the correct notion that teachers must make special preparation for the vocation of teaching. The higher standard demanded of teachers must lead logically to higher salaries for teachers, and constant efforts should be made by all persons interested in education to secure for teachers adequate compensation for their work.

3. The rapid establishment of township or rural high schools is one of the most gratifying evidences of the progress of education. We believe that this movement should be encouraged until the children of rural communities enjoy the benefits of public education to an extent approximating as nearly as practicable the education furnished in urban communities.

4. The association heartily approves of the efforts now being made to determine the proper place of industrial education in the public schools. We believe that the time is rapidly approaching when industrial education should be introduced into all schools and should be made to harmonize with the occupations of the community. These courses when introduced should include instruction in agricultural as well as manual training, etc. Wherever the conditions justify their establishment, schools that show the application of the branches of knowledge to practical life should be established.

5. The National Educational Association strongly recommends the increasing utilization of urban school buildings for free vacation schools and for free evening schools and lecture courses for adults, and for children who have been obliged to leave the day schools prematurely.

6. It is the duty of the state to provide for the education of every child within its borders and to see that all children obtain the rudiments of an education. The constitutional provision that all persons must contribute to the support of the public schools logically carries with it the implied provision that no persons should be permitted to defeat the purposes of the public school law by forcing their children at an early age to become breadwinners.

7. The national government should provide schools for the children of all persons living in territory under the immediate control of the government. The attention of Congress is specially directed to the need of adequate legislation to provide schools for the children of citizens of the United States living on naval reservations.

8. The association regrets the revival in some quarters of the idea that the common school is a place for teaching nothing but reading, spelling, writing and ciphering; and takes this occasion to declare that the ultimate object of popular education is to teach the children how to live righteously, healthily, and

happily, and that to accomplish this object it is essential that every school inculcate the love of truth, justice, purity, and beauty through the study of biography, history, ethics, natural history, music, drawing and manual arts.

9. The National Educational Association wishes to record its approval of the increasing appreciation among educators of the fact that the building of character is the real aim of the schools and the ultimate reason for the expenditure of millions for their maintenance. There is in the minds of the children and youth of to-day a tendency toward a disregard for constituted authority; a lack of respect for age and superior wisdom; a weak appreciation of the demands of duty; a disposition to follow pleasure and interest rather than obligation and order. This condition demands the earnest thought and action of our leaders of opinion, and places important obligations upon school authorities.

10. The National Educational Association wishes to congratulate the secondary schools and colleges of the country that are making the effort to remove the taint of professionalism that has crept into student sports. This taint can be removed only by leading students, alumni and school faculties to recognize that interschool games should be played for sportsmanship and not merely for victory.

11. The National Educational Association observes with great satisfaction the tendency of cities and towns to replace large school committees or boards, which have exercised through subcommittees executive functions, by small boards which determine general policies but entrust all executive functions to salaried experts.

12. Local taxation, supplemented by state taxation, presents the best means for the support of the public schools, and for securing that deep interest in them which is necessary to their greatest efficiency. State aid should be granted only as supplementary to local taxation, and not as a substitute for it.

13. We can not too often repeat that close, intelligent, judicious supervision is necessary for all grades of schools.

14. A free democracy can not long continue without the assistance of a system of state-supported schools administered by agents chosen by the people and responsible to the people for its ideals, its conduct and its results.

Eliphalet Oram Lyte,
of Pennsylvania (Chairman),
Charles J. Baxter, *of New Jersey*,
Edwin G. Cooley, *of Illinois*,
Frank B. Cooper, *of Washington*,
Charles D. McIver, *of North Carolina*,
Miss Anna Tolman Smith,
of District of Columbia.
Miss Harriet Emerson, *of Massachusetts*,
O. J. Kern, *of Illinois*,
Edward J. Goodwin, *of New York*,
William L. Bryan, *of Indiana.*
Committee on Resolutions.

SCIENTIFIC NOTES AND NEWS.

The University of Cape Town conferred honorary doctorates on several members of the British Association on August 17, including the president, Professor G. W. Darwin, of Cambridge; Professor W. M. Davis, of Harvard University, and Professor Porter, of McGill University.

The Ophthalmological Congress, which held its annual meeting from August 2 to 5, awarded the Graefe Medal to Professor Hering, of Leipzig, for his work in the domain of physiological optics.

The Emperor of Austria has made Dr. Karl Toldt, professor of anatomy in the University of Vienna, a life member of the Austrian House of Lords.

Professor J. M. van't Hoff, the eminent physical chemist, has been elected a member of the Academy of Sciences at Turin.

Dr. J. Larmor, of Cambridge, will lecture on mathematical physics at Columbia University during the year 1906–7.

Professor Podwyssotzki, dean of the medical faculty of Odessa, has been appointed director of the Institute for Experimental Medicine at St. Petersburg.

Dr. N. L. Britton, director-in-chief of the New York Botanical Garden, and Mrs. Britton sailed for Bermuda on August 30, to carry out some botanical investigations, returning during the last week in September.

PROFESSOR OMORI, the Japanese seismologist, has concluded his visit to India, where he has been investigating the conditions of earthquakes.

PROFESSOR FREDERICK STARR, of the University of Chicago, has been granted leave of absence of more than a year, which time he will spend among the savage tribes of Central Africa.

A REUTER telegram from Liverpool states that, at the request of the colonial office, the Liverpool School of Tropical Medicine has, with the consent of the university authorities, requested Professor Boyce to visit Belize, in British Honduras, to report on the sanitary measures in that colony necessary in view of the recent outbreak of yellow fever. Professor Boyce, who is now at New Orleans, will, after completing his observations of the methods employed by the Americans in combating yellow fever there, proceed to Belize. The latest mail advices from Brazil have brought news that both members of the yellow fever expedition of the Liverpool School at Manaos have been ill with yellow fever, one very seriously. The latter has now been invalided to Madeira to recuperate, but proposes to return to continue his work. The members of the expedition express the hope that they will now be immune. The medical officers of Manaos have shown them the greatest attention and kindness during their illness. The surviving members of the sleeping sickness expedition which the school sent to the Congo in August, 1903, returned to England by the steamship *Oron* on September 5.

THE *Journal* of the New York Botanical Garden reports that Dr. P. A. Rydberg returned from two months' work in western Utah and Nevada, late in August. A large number of herbarium specimens were secured which will furnish much valuable material for the furtherance of his studies on the flora of the Rocky Mountains. Mr. George V. Nash has recently returned from an exploring trip to the interior of Hayti. Some regions hitherto unvisited by the botanist were reached and a large amount of preserved material, seeds and living plants were secured, together with many valuable notes on distribution. Professor F. E. Lloyd, of Teachers College, has returned from a summer of work at the Desert Laboratory of the Carnegie Institution at Tucson, Arizona. Professor Lloyd is carrying out some investigations upon the transpiration of desert plants under a grant from the Carnegie Institution.

DR. STEPHAN KRUSPER, emeritus professor of mathematics in the Polytechnic School at Buda Pesth, has died at the age of eighty-seven years.

DR. FRANZ REULEAUX, emeritus professor of technology in the Berlin Technological Institute, died on August 20, at the age of seventy-six years.

COUNT DE BRAZZA, known for his explorations in Central Africa, has died while on a special mission from the French government to that region.

MR. J. W. DOUGLAS, one of the editors of the *Entomologist's Monthly Magazine,* died on August 28, in his ninety-first year.

THE eclipse expeditions to Spain were, on September 8, entertained at lunch by the mayor and municipality of Madrid. The toast of the day was proposed by the mayor, Señor Vincenti, and answered by Dr. Janssen, on behalf of the astronomical representatives of France, Germany, Holland, Italy, America, Russia, Spain and Great Britain.

IT has been stated that a member of the Brazilian Chamber of Deputies had proposed that a prize of $2,000,000 should be offered for the discovery of a certain method of stamping out consumption. *The British Medical Journal* announces that the proposal has been approved by the Brazilian Parliament. The offer, however, is larger in scope than was at first reported, for it appears that the prize will be given to any one, native or foreign, who shall discover a certain means of prevention or cure of syphilis, or tuberculosis, or cancer. The Brazilian minister of the interior will, it is said, refer the proposal to a committee composed of a representative of the National Academy of Medicine, and four other members of kindred bodies in France, England, Germany and Italy. The Brazilian govern-

ment will regulate the meetings of the committee.

MESSRS. HOUGHTON, MIFFLIN & Co. announce that they will publish in eight volumes the proceedings of the International Congress of Arts and Science, held at St. Louis, in September, 1904. The volumes, ranging from 500 to 800 pages, have the following titles: 1. 'Philosophy and Mathematics'; 2. 'Politics, Law and Religion'; 3. 'Language, Literature and Art'; 4. 'Inorganic Science'; 5. 'Biology and Psychology'; 6. 'Medicine and Technology'; 7. 'Social Sciences'; 8. 'Education and Religion.' The addresses are printed as they were delivered, except that those in foreign languages have been translated into English. Short bibliographies will be given for each department of learning, and a very full index with references will be added.

MESSRS. CASSELL will publish this autumn 'The Zoological Society of London: a Sketch of its Foundation and Development, and the Story of its Farm, Museum, Gardens, Menagerie and Library,' by Mr. Henry Scherren, F.Z.S. The edition is to be limited to 1,000 copies.

To commemorate the meeting of the British Association in South Africa, a plan has been formulated to found a British Association medal for South African students.

THE International Surgical Society will hold its first congress at Brussels from September 18 to September 23.

THE eighth general meeting of the American Electrochemical Society was held in Bethlehem, from September 18 to 20.

THE department of zoology of Stanford University, has been presented with a large collection of the fresh-water fishes of Mexico by the Field Columbian Museum of Chicago. The collection is the work of Dr. S. E. Meek.

REUTER'S correspondent at Stockholm reports that Professor Nathorst has received a letter in which Lieutenant Bergendahl, who is a member of the Duc d'Orléans's Greenland Expedition, states that on July 27, as the expedition passed Cape Bismarck, unknown land was discovered. It appears that Cape Bismarck lies on a large island, and not on the mainland. The new land has been mapped as well as possible, and has received the name Terre de France. The expedition was unable to penetrate further north than 78° 16′ N. lat.

THE Historical Congress held at Rome in 1903 appointed a permanent international committee to organize an international gathering of those interested in the history of the natural sciences. The chairman was Professor Paul Tannery, of Paris, who died a few months ago. We learn from the *British Medical Journal* that in place of him the committee has now unanimously elected as its chairman Dr. Karl Sudhoff, who has just been appointed professor of the history of medicine in the University of Leipzig. The members of the committee are Drs. Benedikt, of Vienna; Blanchard, of Paris; Bobynin, of Moscow; Cajori, of Colorado Springs; Carpi, of Rome; Eneström, of Stockholm; Favaro, of Padua; Giacosa, of Turin; Guareschi, of Turin; Günther, of Munich; Heath, of London; Korteweg, of Amsterdam; Loria, of Genoa; Petersen, of Copenhagen; Rubio, of Zurich; Saavedra, of Madrid; Smith, of New York; Teixeira, of Oporto; and Zeuthen, of Copenhagen.

Nature states that at the annual meeting of the Academy of the Lincei, which was held on June 4 in the presence of the King and Queen of Italy, the president, Professor Blaserna, announced the result of the competition for the three Royal prizes founded by the late King Humbert. In the section of normal and pathological physiology, the prize is awarded to Professor Aristide Stefani, of Padua, for his published work dealing with the physiology of the heart and circulation, the non-acoustic functions of the labyrinth of the ear, and the serotherapeutic treatment of pneumonia. In the sections of archeology and of economic and social science, the judges reported that the competitors were not of sufficient merit to justify the award of the prizes. This is the first occasion on which so small a proportion of the prizes have been conferred, and it is proposed that in future the section of archeology shall embrace not only classical, but also christian and medieval archeology. Minis-

terial premiums intended to aid original work among teachers in secondary schools were awarded in the department of mathematical sciences to Professor Ciani (£50), Professor Pirondini (£38), and Professor Chini (£20). Out of the funds available from the Carpi prize, a sum of £32 was awarded to Dr. P. Enriques for a thesis on the changes brought about in absorbed chlorophyll by the action of the liver, and the relation existing between the derivatives of chlorophyll produced in the organism and the genesis of the hematic pigments. In his address the vice-president, F. d'Ovidio, discussed in general terms the question 'Art for Art's Sake,' dealing more particularly with the influence exerted on national life and character by art and literature.

THE autumn course of lectures of the New York Botanical Garden will be delivered in the lecture hall of the museum, on Saturday afternoons, at 4:30 P.M., as follows:

October 7, 'Autumn Features of Native Trees and Shrubs,' by Dr. N. L. Britton.

October 14, 'The Faculties of Plants,' by Dr. D. T. MacDougal.

October 21, 'Botanical Explorations in Hayti,' by Mr. Geo. V. Nash.

October 28, 'A Summer in the Desert,' by Professor Francis E. Lloyd.

November 4, 'The Sea-gardens of Tropical America,' by Dr. M. A. Howe.

November 11 (subject to be announced), by Dr. W. A. Murrill.

November 18, 'Fossil Plants,' by Dr. Arthur Hollick.

November 25, 'Tropical Fruits,' by Professor H. H. Rusby.

The director-in-chief and other members of the staff will be pleased to receive members and their friends at the grounds in Bronx Park, every Saturday for which lectures are announced. Opportunity will be given for inspection of museums, laboratories, library, herbaria, the public conservatories, the herbaceous collection, the hemlock forest and parts of the arboretum site.

THE bridge over the Zambesi River in Africa has been formally opened in the presence of the visiting members of the British Association. Professor Darwin made the opening speech.

THE New York *Evening Post* states that Major von Donat, the author of the well-known plan for the drainage and colonization of the Pontine Marshes, has placed before the Bavarian government a project for creating a source of electric power sufficient to run all the railways of the country. He would secure this power by damming the River Isar between Wallgau and Vorderritz, thus creating a new lake, and connecting this with the Walchensee and the Kochelsee. He has figured out that this would effect a saving of $10,000,000 a year.

CONSUL STEPHENS, of Plymouth, reports that a new return has just been issued for the first time by the British government. It is the counterpart of the alien immigration returns, and deals with the number of passengers who leave England for places out of Europe, discriminating between the British Empire and foreign countries. It appears that in the month of July, 21,000 Britons emigrated, two thirds being from England, 4,392 from Scotland, and 2,631 from Ireland. That is a reduction of 1,664 as compared with the corresponding month of last year. As regards the past seven months, British emigrants numbered about 151,000, an increase of 13,447. England contributed 98,460, Scotland 24,116, and Ireland 28,333. Of British and Scotch emigrants, rather more than one half go to British colonies, and Canada takes by far the greatest proportion of them. The Irish, however, prefer the United States, with the result that the republic gets more British people than Canada. It is claimed that the English and Scotch are far more partial to the Dominion than to the United States, and sent 55,000 emigrants there as against 2,000 Irish in the 7 months. South Africa holds the next place in popularity, and has taken nearly 13,000 Britons in the 7 months, while Australia attracted 6,325. The returns also show that 110,000 foreigners left the United Kingdom, chiefly for the United States, in the past 7 months.

CONSUL KEHL, of Stettin, writes explaining new regulations that have been issued for the admission of students to technical high schools in Prussia. He says: The students will be di-

vided into three classes—the 'regular attending students,' students for lectures only, and lecture-visitors. As regular students, without any exception, such young men will be accepted who have acquired the knowledge necessary for being admitted into any university, said knowledge to have been acquired at a German 'Gymnasium,' a German 'Oberrealschule' (a high school in which sciences as well as art and languages are taught), a Bavarian 'industrial school,' or the Saxonian Polytechnical Academy of Chemnitz. As to foreigners, the ministry of ecclesiastical affairs and public education is to decide whether their scholastic erudition is sufficient to admit them. German subjects, other than Prussian, will be admitted under the same conditions as Prussian subjects. As students admitted to hear the lectures only (*i. e.*, without privilege of being graduated by the board of examiners), young men will be admitted, not possessed of the education necessary for being admitted into a German university, but having acquired the schooling necessary for performing only one year's military service. The admission of such students is put into the hands of the rector of the technical high school. As lecture visitors such persons may be admitted to the lectures or demonstrations who are not eligible to either of the two classes just mentioned. The admission of lecture visitors will be granted by the rector, with the consent of the proper professor. There is particularly one new restriction in these regulations, viz., that all encouragements for foreigners are dropped. Setting aside the lecture visitors, only such foreigners will be admitted as are capable of complying with the German educational requirements or who are in possession of an equivalent foreign certificate of learning.

UNIVERSITY AND EDUCATIONAL NEWS.

Announcement is made of an anonymous gift to the Lebanon Valley College, Annville, Pa., of a hall of science to cost $80,000. Work on the building is to begin at once.

Mr. E. G. Bawden, London, has entrusted Mr. Edgar Speyer 'with a sum in cash and securities of about £100,000 to be applied to purposes of charity and benevolence, and for the advancement of knowledge, especially in aid of human suffering.' This sum has been apportioned for various purposes in the form of capital to be vested in trustees, and to be known in each case as the 'Bawden Fund.' The largest allotment is £16,000 to complete the sum of £200,000 required to bring about the incorporation of the University College in the University of London.

Girton College, Cambridge, has received £2,000 by the will of Miss Elizabeth A. Manning.

An imperial ukase has been issued at St. Petersburg, granting a liberal measure of autonomy to universities, pending the elaboration of permanent regulations. This is expected to ensure the opening of the universities and the resumption of the educational life of Russia, which has been at a stand still since February. The ukase places the election of rectors and deans of the universities, who have hitherto been appointed by the minister of education, in the hands of the university professors. The duty of seeing that academic life follows a normal and orderly course is entrusted by the ukase to professorial councils, to which has been confided jurisdiction over offences by students.

Dr. Chase Palmer, for some years professor of chemistry at the Central University of Kentucky, has accepted the position of professor of chemistry in the State College at Lexington, Ky., Dr. J. H. Kastle, who occupied the latter position, having recently gone to Washington as chief of the division of chemistry in the Hygienic Laboratory of the Marine Hospital Service.

Dr. Friend E. Clark, who has for two years been instructor in industrial chemistry in the Pennsylvania State College, has been appointed professor of chemistry in the Central University of Kentucky, at Danville.

Dr. J. Bendixson has been elected professor of mathematics in the University of Stockholm.

Dr. Oskar Brefeld, professor of botany at Breslau, has retired owing to failing eyesight.

SCIENCE

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FRIDAY, SEPTEMBER 29, 1905.

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE PROGRESS OF PHYSICS IN THE NINETEENTH CENTURY.

II.

DIFFRACTION.

Though diffraction dates back to Grimaldi (1665) and was well known to Newton (1704), the first correct though crude interpretation of the phenomenon is due to Young (1802, 1804). Independently Fresnel (1815) in his original work devised similar explanations, but later (1818, 1819, 1826) gave a more rational theory in terms of Huyghens's principle, which he was the first to adequately interpret. Fresnel showed that all points of a wave front are concerned in producing diffraction, though the ultimate critical analysis was left to Stokes (1849).

In 1822 Fraunhofer published his remarkable paper, in which, among other inventions, he introduced the grating into science. Zone plates were studied by Cornu (1875) and by Soret (1875). Rowland's concave grating appeared in 1881. Michelson's echelon spectrometer in 1899.

The theory of gratings and other diffraction phenomena was exhaustively treated by Schwerd (1837). Babinet established the principle bearing his name in 1837. Subsequent developments were in part concerned with the improvement of Fresnel's method of computation, in part with a more rigorous treatment of the theory of diffraction. Stokes (1850, 1852) gave the first account of the polarization accompanying diffraction, and thereafter Rayleigh (1871) and many others, including

Kirchhoff (1882, 1883), profoundly modified the classic treatment. Airy (1834, 1838) and others elaborately examined the diffraction due to a point source in view of its important bearing on the efficiency of optical instruments.

A unique development of diffraction is the phenomenon of scattering propounded by Rayleigh (1871) in his dynamics of the blue sky. This great theory which Rayleigh has repeatedly improved (1881, et seq.) has since superseded all other relevant explanations.

POLARIZATION.

An infinite variety of polarization phenomena grew out of Bartholinus's (1670) discovery. Sound beginnings of a theory were laid by Huyghens ('Traité,' 1690), whose wavelet principle and elementary wave front have persisted as an invaluable acquisition, to be generalized by Fresnel in 1821.

Fresh foundations in this department of optics were laid by Malus (1810) in his discovery of the cosine law and the further discovery of the polarization of reflected light. Later (1815) Brewster adduced the conditions of maximum polarization for this case.

In 1811 Arago announced the occurrence of interferences in connection with parallel plane-polarized light, phenomena which under the observations of Arago and Fresnel (1816, 1819), Biot (1816), Brewster (1813, 1814, 1818) and others grew immensely in variety, and in the importance of their bearing on the undulatory theory. It is on the basis of these phenomena that Fresnel in 1819 insisted on the transversality of light waves, offering proof which was subsequently made rigorous by Verdet (1850). Though a tentative explanation was here again given by Young (1814), the first adequate theory of the behavior of thin plates of aeolotropic media with polarized light came from Fresnel (1821).

Airy (1833) elucidated a special case of the gorgeously complicated interferences obtained with convergent pencils; Neumann in 1834 gave the general theory. The forbidding equations resulting were geometrically interpreted by Bertin (1861, 1884), and Lommel (1883) and Neumann (1841) added a theory for stressed media, afterwards improved by Pockels (1889).

The peculiarly undulatory character of natural light owes its explanation largely to Stokes (1852), and his views were verified by many physicists, notably by Fizeau (1862) showing interferences for path differences of 50,000 wave-lengths and by Michelson for much larger path differences.

The occurrence of double refraction in all non-regular crystals was recognized by Haüy (1788) and studied by Brewster (1818). In 1821, largely by a feat of intuition, Fresnel introduced his generalized elementary wave surface, and the correctness of his explanation has since been substantiated by a host of observers. Stokes (1862, et seq.) was unremittingly active in pointing out the theoretical bearing of the results obtained. Hamilton (1832) supplied a remarkable criterion of the truth of Fresnel's theory deductively, in the prediction of both types of conic refraction. The phenomena were detected experimentally by Lloyd (1833).

The domain of natural rotary polarization, discovered by Arago (1811) and enlarged by Biot (1815), has recently been placed in close relation to non-symmetrical chemical structure by LeBel (1874) and van't Hoff (1875), and a tentative molecular theory was advanced by Sohncke (1876).

Boussinesq (1868) adapted Cauchy's theory (1842) to these phenomena. Independent elastic theories were propounded

by MacCullagh (1837), Briot, Sarrau (1868); but there is naturally no difficulty in accounting for rotary polarization by the electromagnetic theory of light, as was shown by Drude (1892).

Among investigational apparatus of great importance the Soleil (1846, 1847) saccharimeter may be mentioned.

THEORIES.

In conclusion, a brief summary may be given of the chief mechanisms proposed to account for the undulations of light. Fresnel suggested the first adequate optical theory in 1821, which, though singularly correct in its bearing on reflection and refraction in the widest sense, was merely tentative in construction. Cauchy (1829) proposed a specifically elastic theory for the motion of relatively long waves of light in continuous media, based on a reasonable hypothesis of molecular force, and deduced therefrom Fresnel's reflection and refraction equations. Green (1838), ignoring molecular forces and proceeding in accordance with his own method in elastics, published a different theory, which did not, however, lead to Fresnel's equations. Kelvin (1888) found the conditions implied in Cauchy's theory compatible with stability if the ether were considered as bound by a rigid medium. The ether implied throughout is to have the same elasticity everywhere, but to vary in density from medium to medium, and vibration to be normal to the plane of polarization.

Neumann (1835), whose work has been reconstructed by Kirchhoff (1876), and MacCullagh (1837), with the counter-hypothesis of an ether of fixed density but varying in elasticity from medium to medium, also deduced Fresnel's equations, obtaining at the same time better surface conditions in the case of æolotropic media. The vibrations are in the plane of polarization.

All the elastic theories essentially predict a longitudinal light wave. It was not until Kelvin in 1889, 1890 proposed his remarkable gyrostatic theory of light, in which force and displacement become torque and twist, that these objections to the elastic theory were wholly removed. MacCullagh, without recognizing their bearing, seems actually to have anticipated Kelvin's equation.

With the purpose of accounting for dispersion, Cauchy in 1835 gave greater breadth to his theory by postulating a sphere of action of ether particles commensurate with wave-length, and in this direction he was followed by F. Neumann (1841), Briot (1864), Rayleigh (1871) and others, treating an ether variously loaded with material particles. Among theories beginning with the phenomena observed, that of Boussinesq (1867, et seq.) has received the most extensive development.

The difficult surface conditions met with when light passes from one medium to another, including such subjects as ellipticity, total reflection, etc., have been critically discussed, among others, by Neumann (1835) and Rayleigh (1888); but the discrimination between the Fresnel and the Neumann vector was not accomplished without misgiving before the advent of the work of Hertz.

It appears, therefore, that the elastic theories of light, if Kelvin's gyrostatic adynamic ether be admitted, have not been wholly routed. Nevertheless, the great electromagnetic theory of light propounded by Maxwell (1864, 'Treatise,' 1873) has been singularly apt not only in explaining all the phenomena reached by the older theories and in predicting entirely novel results, but in harmoniously uniting as parts of a unique doctrine, both the electric

or photographic light vector of Fresnel and Cauchy and the magnetic vector of Neumann and MacCullagh. Its predictions have, moreover, been astonishingly verified by the work of Hertz (1890), and it is to-day acquiring added power in the convection theories of Lorentz (1895) and others.

ELECTROSTATICS.

Coulomb's (1785) law antedates the century; indeed, it was known to Cavendish (1771, 1781). Problems of electric distribution were not seriously approached, however, until Poisson (1811) solved the case for spheres in contact. Afterwards Clausius (1852), Helmholtz (1868) and Kirchhoff (1877) examined the conditions for discs, the last giving the first rigorous theory of the experimentally important plate condenser. In 1845, 1848 the investigation of electric distribution received new incentive as an application of Kelvin's beautiful method of images. Maxwell ('Treatise,' 1873) systematized the treatment of capacity and induction coefficients.

Riess (1837) in a classic series of experiments on the heat produced by electrostatic discharge virtually deduced the potential energy of a conductor and in a measure anticipated Joule's law (1841). In 1860 appeared Kelvin's great paper on the electromotive force needed to produce a spark. As early as 1855, however, he had shown that the spark discharge is liable to be of the character of a damped vibration and the theory of electric oscillation was subsequently extended by Kirchhoff (1867). The first adequate experimental verification is due to Feddersen (1858, 1861).

The specific inductive capacity of a medium with its fundamental bearing on the character of electric force was discovered by Faraday in 1837. Of the theories propounded to account for this property the most far reaching is Maxwell's (1865), which culminates in the unique result showing that the refraction index of a medium is the square root of its specific inductive capacity. With regard to Maxwell's theory of the Faraday stress in the ether as compared with the subsequent development of electrostriction in other media by many authors, notably by Boltzmann (1880) and by Kirchhoff (1885), it is observable that the tendency of the former to assign concrete physical properties to the tube of force is growing, particularly in connection with radioactivity. Duhem (1892, 1895) insists, however, on the greater trustworthiness of the thermodynamic potential.

The seemingly trivial subject of pyroelectricity interpreted by Æpinus (1756) and studied by Brewster (1825), has none the less elicited much discussion and curiosity, a vast number of data by Hankel (1839–93) and others and a succinct explanation by Kelvin (1860, 1878). Similarly piezoelectricity, discovered by the brothers Curie (1880), has been made the subject of a searching investigation by Voigt (1890). Finally Kerr (1875, et seq.) observed the occurrence of double refraction in an electrically polarized medium. Recent researches, among which those of Lemoine (1896) are most accurate, have determined the phase difference corresponding to the Kerr effect under normal conditions, while Voigt (1899) has adduced an adequate theory.

Certain electrostatic inventions have had a marked bearing on the development of electricity. We may mention in particular Kelvin's quadrant electrometer (1867) and Lippmann's capillary electrometer (1873). Moreover, among apparatus originating in Nicholson's duplicator (1788) and Volta's electrophorus, the Töpler-Holtz machine (1865–67), with the recent improvement due to Wimshurst, has,

replaced all others. Atmospheric electricity, after the memorable experiment of Franklin (1751), made little progress until Kelvin (1860) organized a systematic attack. More recently a revival of interest began with Exner (1886), but more particularly with Linss (1887), who insisted on the fundamental importance of a detailed knowledge of atmospheric conduction. It is in this direction that the recent vigorous treatment of the atmosphere as an ionized medium has progressed, owing chiefly to the indefatigable devotion of Elster and Geitel (1899, et seq.) and of C. T. R. Wilson (1897, et seq.). Qualitatively the main phenomena of atmospheric electricity are now plausibly accounted for; quantitatively there is as yet very little specific information.

VOLTA CONTACTS.

Volta's epoch-making experiment of 1797 may well be added to the century which made such prolific use of it; indeed, the Voltaic pile (1800–02) and Volta's law of series (1802) come just within it. Among the innumerable relevant experiments Kelvin's dropping electrodes (1859) and his funnel experiment (1867) are among the more interesting, while the 'Spannungsreihe' of R. Kohlrausch (1851, 1853) is the first adequate investigation. Nevertheless, the phenomenon has remained without a universally acceptable explanation until the present day, when it is reluctantly yielding to electronic theory, although ingenious suggestions like Helmholtz's 'Doppelschicht' (1879), the interpretations of physical chemistry and the discovery of the concentration cell (Helmholtz; Nernst, 1888, 1889; Planck, 1890) have thrown light upon it.

Among the earliest theories of the galvanic cell is Kelvin's (1851, 1860), which, like Helmholtz's, is incomplete. The most satisfactory theory is Nernst's (1889). Gibbs (1878) and Helmholtz (1882) have made searching critical contributions, chiefly in relation to the thermal phenomena.

Volta's invention was made practically efficient in certain famous galvanic cells, among which Daniell's (1836), Grove's (1839), Clarke's (1878), deserve mention, and for the purposes of measurement have been subserved by the potentiometers of Poggendorff (1841), Bosscha (1855), Clarke (1873).

SEEBECK CONTACTS.

Thermoelectricity, destined to advance many departments of physics, was discovered by Seebeck in 1821. The Peltier effect followed in 1834, subsequently to be interpreted by Icilius (1853). A thermodynamic theory of the phenomena came from Clausius (1853) and with greater elaboration, together with the discovery of the Thomson effect, from Kelvin (1854, 1856), to whom the thermoelectric diagram is due. This was subsequently developed by Tait (1872, et seq.) and his pupils. Avenarius (1863), however, first observed the thermoelectric parabola.

The modern platinum-iridium or platinum-rhodium thermoelectric pyrometer dates from about 1885 and has recently been perfected at the Reichsanstalt. Melloni (1835, et seq.) made the most efficient use of the thermopyle in detecting minute temperature differences.

ELECTROLYSIS.

Though recognized by Nichols and Carlisle (1800) early in the century, the laws of electrolysis awaited the discovery of Faraday (1834). Again, it was not till 1853 that further marked advances were made by Hittorf's (1853–59) strikingly original researches on the velocities of the ions. Later Clausius (1857) suggested an adequate theory of electrolysis, which was

subsequently to be specialized in the dissociation hypothesis of Arrhenius (1881, 1884). To the elaborate investigations of F. Kohlrausch (1879, et seq.), however, science owes the fundamental law of the independent velocities of migration of the ions.

Polarization discovered by Ritter in 1803 became in the hands of Plante (1859–1879) an invaluable means for the storage of energy, an application which was further improved by Faure (1880).

STEADY FLOW.

The fundamental law of the steady flow of electricity, in spite of its simplicity, proved to be peculiarly elusive. True, Cavendish (1771–81) had definite notions of electrostatic resistance as dependent on length section and potential, but his intuitions were lost to the world. Davy (1820), from his experiments on the resistances of conductors, seems to have arrived at the law of sections, though he obscured it in a misleading statement. Barlow (1825) and Becquerel (1825–26), the latter operating with the ingenious differential galvanometer of his own invention, were not more definite. Surface effects were frequently suspected. Ohm himself, in his first paper (1825), confused resistance with the polarization of his battery, and it was not till the next year (1826) that he discovered the true law, eventually promulgated in his epoch-making 'Die galvanische Kette' (1827).

It is well known that Ohm's mathematical deductions were unfortunate, and would have left a gap between electrostatics and voltaic electricity. But after Ohm's law had been further experimentally established by Fechner (1830), the correct theory was given by Kirchhoff (1849) in a way to bridge over the gap specified. Kirchhoff approached the question gradually, considering first the distribution of current in a plane conductor (1845–1846), from which he passed to the laws of distribution in branched conductors (1847–48)—laws which now find such universal application. In his great paper, moreover, Kirchhoff gives the general equation for the activity of the circuit and from this Clausius (1852) soon after deduced the Joule effect theoretically. The law, though virtually implied in Riess's results (1837), was experimentally discovered by Joule (1841).

As bearing critically or otherwise on Ohm's law we may mention the researches of Helmholtz (1852), of Maxwell (1876), the solution of difficult problems in regard to terminals or of the resistance of special forms of conductors, by Rayleigh (1871, 1879), Hicks (1883) and others, the discussion of the refraction of lines of flow by Kirchhoff (1845), and many researches on the limits of accuracy of the law.

Finally, in regard to the evolution of the modern galvanometer from its invention by Schweigger (1820), we may enumerate in succession Nobili's astatic system (1834), Poggendorff's (1826) and Gauss's (1833) mirror device, the aperiodic systems, Weber's (1862) and Kelvin's critical study of the best condition for galvanometry, so cleverly applied in the instruments of the latter. Kelvin's siphon recorder (1867), reproduced in the Depretz-D'Arsonval system (1882), has adapted the galvanometer to modern conditions in cities. For absolute measurement Pouillet's tangent galvanometer (1837), treated for absolute measurement by Weber (1840), and Weber's dynamometer (1846) have lost little of their original importance.

MAGNETISM.

Magnetism, definitely founded by Gilbert (1600) and put on a quantitative basis by Coulomb (1785), was first made the subject of recondite theoretical treatment by

Poisson (1824–27). The interpretation thus given to the mechanism of two conditionally separable magnetic fluids facilitated discussion and was very generally used in argument, as for instance by Gauss (1833) and others, although Ampère had suggested the permanent molecular current as early as 1820. Weber (1852) introduced the revolable molecular magnet, a theory which Ewing (1890) afterwards generalized in a way to include magnetic hysteresis. The phenomenon itself was independently discovered by Warburg (1881) and by Ewing (1882) and has since become of special practical importance.

Faraday in 1852 introduced his invaluable conception of lines of magnetic force, a geometric embodiment of Gauss's (1813, 1839) theorem of force flux, and Maxwell (1855, 1862, et seq.) thereafter gave the rigorous scientific meaning to this conception, which pervades the whole of cotemporaneous electromagnetics.

The phenomenon of magnetic induction, treated hypothetically by Poisson (1824–27) and even by Barlow (1820), has since been attacked by many great thinkers, like F. Neumann (1848), Kirchhoff (1854); but the predominating and most highly elaborated theory is due to Kelvin (1849, et seq.). This theory is broad enough to be applicable to æolotropic media and to it the greater part of the notation in current use throughout the world is due. A new method of attack of great promise has, however, been introduced by Duhem (1888, 1895, et seq.) in his application of the thermodynamic potential to magnetic phenomena.

Magneticians have succeeded in expressing the magnetic distribution induced in certain simple geometrical figures like the sphere, the spherical shell, the ellipsoid, the infinite cylinder, the ring. Green in 1828 gave an original but untrustworthy treatment for the finite cylinder. Lamellar and solenoidal distributions are defined by Kelvin (1850), to whom the similarity theorems (1856) are also due. Kirchhoff's results for the ring were practically utilized in the absolute measurements of Stoletow (1872) and of Rowland (1878).

Dimagnetism, though known since Brugmans (1778), first challenged the permanent interest of science in the researches of Becquerel (1827) and of Faraday (1845). It is naturally included harmoniously in Kelvin's great theory (1847, et seq.). Independent explanations of diamagnetism, however, have by no means abandoned the field; one may instance Weber's (1852) ingenious generalization of Ampère's molecular currents (1820) and the broad critical deductions of Duhem (1889) from the thermodynamic potential. For the treatment of æolotropic magnetic media, Kelvin's (1850, 1851) theory seems to be peculiarly applicable. Weber's theory would seem to lend itself well to electronic treatment.

The extremely complicated subject of magnetostriction, originally observed by Matteuci (1847) and by Joule (1849) in different cases, and elaborately studied by Wiedemann (1858, et seq.), has been repeatedly attacked by theoretical physicists, among whom Helmholtz (1881), Kirchhoff (1885), Boltzmann (1879) and Duhem (1891) may be mentioned. None of the carefully elaborated theories accounts in detail for the facts observed.

The relations of magnetism to light have increased in importance since the fundamental discoveries of Faraday (1845) and of Verdet (1854), and they have been specially enriched by the magneto-optic discoveries of Kerr (1876, et seq.), of Kundt (1884, et seq.), and more recently by the Zeemann effect (1897, et seq.). Among the theories put forth for the latter, the electronic explanation of Lorentz (1898, 1899) and that of Voigt (1899) are

supplementary or at least not contradictory. The treatment of the Kerr effect has been systematized by Drude (1892, 1893). The instantaneity of the rotational effect was first shown by Bichat and Blondlot (1882) and this result has since been found useful in chronography. Sheldon demonstrated the possibility of reversing the Faraday effect. Finally terrestrial magnetism was revolutionized and made accessible to absolute measurement by Gauss (1833), and his method served Weber (1840, et seq.) and his successors as a model for the definition of absolute units throughout physics. Another equally important contribution from the same great thinker (1840) is the elaborate treatment of the distribution of terrestrial magnetism, the computations of which have been twice modernized, in the last instance by Neumeyer[1] (1880). Magnetometric methods have advanced but little since the time of Gauss (1833), and Weber's (1853) earth inductor remains a standard instrument of research. Observationally, the development of cycles of variation in the earth's constants is looked forward to with eagerness, and will probably bear on an adequate theory of terrestrial magnetism, yet to be framed. Arrhenius (1903) accentuates the importance of the solar cathode torrent in its bearing on the earth's magnetic phenomena.

ELECTROMAGNETISM.

Electromagnetism considered either in theory or in its applications is, perhaps, the most conspicuous creation of the nineteenth century. Beginning with Oersted's great discovery of 1820, the quantitative measurements of Biot and Savart (1820) and Laplace's (1821) law followed in quick succession. Ampère (1820) without delay propounded his famous theory of magnetism. For many years the science was conveniently subserved by Ampère's swimmer (1820), though his functions have since advantageously yielded to Fleming's hand rule for moving current elements. The induction produced by ellipsoidal coils or the derivative cases is fully understood. In practise the rule for the magnetic circuit devised by the Hopkinsons (1886) is in general use. It may be regarded as a terse summary of the theories of Euler (1780), Faraday, Maxwell and particularly Kelvin (1872), who already made explicit use of it. Nevertheless, the clear-cut practical interpretation of the present day had to be gradually worked out by Rowland (1873, 1884), Bosanquet (1883–85), Kapp (1885) and Pisati (1890).

The construction of elementary motors was taken up by Faraday (1821), Ampère (1822), Barlow (1822) and others, and they were treated rather as laboratory curiosities; for it was not until 1857 that Siemens devised his shuttle wound armature and the development of the motor thereafter went *pari passu* with the dynamo to be presently considered. It culminated in a new principle in 1888 when Ferraris, and somewhat later Tesla (1888) and Borel (1888), introduced polyphase transmission and the more practical realization of Arago's rotating magnetic field (1824).

Theoretical electromagnetics, after a period of quiescence, was again enriched by the discovery of the Hall effect (1879, et seq.), which at once elicited wide and vigorous discussion, and for which Rowland (1880), Lorentz (1883), Boltzmann (1886) and others put forward theories of continually increasing finish. Nernst and V. Ettingshausen (1886, 1887) afterwards added the thermomagnetic effect.

[1] Dr. L. A. Bauer kindly called my attention to the more recent work of A. Schmidt, summarized in Dr. Bauer's own admirable paper.

ELECTRODYNAMICS.

The discovery and interpretation of electrodynamic phenomena were the burden of the unique researches of Ampère (1820, et seq., 'Memoir,' 1826). Not until 1846, however, were Ampère's results critically tested. This examination came with great originality from Weber using the bifilar dynamometer of his own invention. Grassmann (1845), Maxwell (1873) and others have invented elementary laws differing from Ampère's; but as Stefan (1869) showed that an indefinite number of such laws might be constructed to meet the given integral conditions, the original law is naturally preferred.

INDUCTION.

Faraday (1831, 1832) did not put forward the epoch-making discovery of electrokinetic induction in quantitative form, as the great physicist was insufficiently familiar with Ohm's law. Lentz, however, soon supplied the requisite interpretation in a series of papers (1833, 1835) which contain his well-known law both for the mutual inductions of circuits and of magnets and circuits. Lentz clearly announced that the induced quantity is an electromotive force, independent of the diameter and metal and varying, *cæt. par.*, with the number of spires. The mutual induction of circuits was first carefully studied by Weber (1846), later by Filici (1852), using a zero method, and Faraday's self-induction by Edlund (1849), while Matteuci (1854) attested the independence of induction of the interposed non-magnetic medium. Henry (1842) demonstrated the successive induction of induced currents.

Curiously enough the occurrence of eddy currents in massive conductors moving in the magnetic field was announced from a different point of view by Arago (1824–26) long before Faraday's great discovery. They were but vaguely understood, however, until Foucault (1855) made his investigation. The general problem of the induction to be anticipated in massive conductor is one of great interest and Helmholtz (1870), Kirchhoff (1891), Maxwell (1873), Hertz (1880) and others have treated it for different geometrical figures.

The rigorous expression of the law of induction was first obtained by F. Neumann (1845, 1847) on the basis of Lentz's law, both for circuits and for magnets. W. Weber (1846) deduced the law of induction from his generalized law of attraction. More acceptably, however, Helmholtz (1847), and shortly after him Kelvin (1848), showed the law of induction to be a necessary consequence of the law of the conservation of energy, of Ohm's and Joule's law. In 1851 Helmholtz treated the induction in branched circuits. Finally Faraday's 'electrotonic state' was mathematically interpreted thirty years later, by Maxwell, and to-day, under the name of electromagnetic momentum, it is being translated into the notation of the electronic theory.

Many physicists following the fundamental equation of Neumann (1845, 1847) have developed the treatment of mutual and self induction with special reference to experimental measurement.

On the practical side the magneto-inductor may be traced back to d'al Negro (1832) and to Pixii (1832). The tremendous development of induction electric machinery which followed the introduction of Siemens's (1857) armature can only be instanced. In 1867 Siemens, improving upon Wilde (1866), designed electric generators without permanent magnets. Pacinotti (1860) and later Gramme (1871) invented the ring armature, while von Hefner-Alteneck (1872) and others improved the drum armature. Thereafter further progress was rapid.

It took a different direction in connec-

tion with the Ferraris (1888) motor by the development of the induction coil of the laboratory (Faraday, 1831; Neef, 1839; Ruhmkoff, 1853) into the transformer (Gaulard and Gibbs, 1882–84) of the arts. Among special apparatus Hughes (1879) contributed the induction balance and Tesla (1891) the high frequency transformer. The Elihu Thompson effect (1887) has also been variously used.

In 1860 Reiss devised a telephone in a form, however, not at once capable of practical development. Bell in 1875 invented a different instrument which needed only the microphone (1878) of Hughes and others to introduce it permanently into the arts. Of particular importance in its bearing on telegraphy, long associated with the names of Gauss and Weber (1833) or practically with Morse and Vail (1837), is the theory of conduction with distributed capacity and inductance established by Kelvin (1856) and extended by Kirchhoff (1857). The working success of the Atlantic cable demonstrated the acumen of the guiding physicist.

ELECTRIC OSCILLATION.

The subject of electric oscillation announced in a remarkable paper of Henry in 1842 and threshed out in its main features by Kelvin in 1856, followed by Kirchhoff's treatment of the transmission of oscillations along a wire (1857), has become of discriminating importance between Maxwell's theory of the electric field and the other equally profound theories of an earlier date. These crucial experiments contributed by Hertz (1887, et seq.) showed that electromagnetic waves move with the velocity of light, and like it are capable of being reflected, refracted, brought to interference and polarized. A year later Hertz (1888) worked out the distribution of the vectors in the space surrounding the oscillatory source. Lecher (1890) using an ingenious device of parallel wires, Blondlot (1891) with a special oscillator, and with greater accuracy Trowbridge and Duane (1895) and Saunders (1896), further identified the velocity of the electric wave with that of the wave of light. Simultaneously the reasons for the discrepancies in the strikingly original method for the velocity of electricity due to Wheatstone (1834), and the American and other longitude observations (Walker, 1894; Mitchell, 1850; Gould, 1851), became apparent, though the nature of the difficulties had already appeared in the work of Fizeau and Gounelle (1850).

Some doubt was thrown on the details of Hertz's results by Sarasin and de la Rive's phenomenon of multiple resonance (1890), but this was soon explained away as the necessary result of the occurrence of damped oscillations by Poincaré (1891), by Bjerknes (1891) and others. J. J. Thomson (1891), contributed interesting results for electrodeless discharges, and on the value of the dielectric constant for slow oscillations (1889); Boltzmann (1893) examined the interferences due to thin plates; but it is hardly practicable to summarize the voluminous history of the subject. On the practical side, we are to-day witnessing the astoundingly rapid growth of Hertzian wave wireless telegraphy, due to the successive inventions of Branly (1890, 1891), Popoff, Braun (1899) and the engineering prowess of Marconi. In 1901 these efforts were crowned by the incredible feat of Marconi's first message from Poldhu to Cape Breton, placing the old world within electric earshot of the new.

Maxwell's equations of the electromagnetic field were put forward as early as 1864, but the whole subject is presented in its broadest relations in his famous treatise of 1873. The fundamental feature of Maxwell's work is the recognition of the displacement current, a conception by

which Maxwell was able to annex the phenomena of light to electricity. The methods by which Maxwell arrived at his great discoveries are not generally admitted as logically binding. Most physicists prefer to regard them as an invaluable possession as yet unliquidated in logical coin; but of the truth of his equations there is no doubt. Maxwell's theory has been frequently expounded by other great thinkers, by Rayleigh (1881), by Poincaré (1890), by Boltzmann (1890), by Heaviside (1889), by Hertz (1890), by Lorentz and others. Hertz and Heaviside, in particular, have condensed the equations into the symmetrical form now commonly used. Poynting (1884) contributed his remarkable theorem on the energy path.

Prior to 1870 the famous law of Weber (1846) had gained wide recognition, containing as it did Coulomb's law, Ampère's law, Laplace's law, Neumann's law of induction, the conditions of electric oscillation and of electric convection. Every phenomenon in electricity was deducible from it compatibly with the doctrine of the conservation of energy. Clausius (1878), moreover, by a logical effort of extraordinary vigor established a similar law. Moreover, the early confirmation of Maxwell's theory in terms of the dielectric constant and refractive index of the medium was complex and partial. Rowland's (1876, 1889) famous experiment of electric convection, which has recently been repeatedly verified by Pender and Cremieu and others, though deduced from Maxwell's theory, is not incompatible with Weber's view. Again the ratio between the electrostatic and the electromagnetic system of units, repeatedly determined from the early measurement of Maxwell (1868) to the recent elaborate determinations of Abraham (1892) and Margaret Maltby (1897), with an ever closer approach to the velocity of light, was at its inception one of the great original feats of measurement of Weber himself associated with Kohlrausch (1856). The older theories, however, are based on the so-called action at a distance or on the instantaneous transmission of electromagnetic force. Maxwell's equations, while equally universal with the preceding, predicate not merely a finite time of transmission, but transmission at the rate of the velocity of light. The triumph of this prediction in the work of Hertz has left no further room for reasonable discrimination.

As a consequence of the resulting enthusiasm, perhaps, there has been but little reference in recent years to the great investigation of Helmholtz (1870, 1874), which includes Maxwell's equations as a special case; nor to his later deduction (1886, 1893) of Hertz's equations from the principle of least action. Nevertheless, Helmholtz's electromagnetic potential is deduced rigorously from fundamental principles and contains, as Duhem (1901) showed, the electromagnetic theory of light.

Maxwell's own vortex theory of physical lines of force (1861, 1862) probably suggested his equations. In recent years, however, the efforts to deduce them directly from apparently simpler properties of a continuous medium, as for instance from its ideal elastics, or again from a specialized ether, have not been infrequent. Kelvin (1890) with his quasi-rigid ether, Boltzmann (1893), Sommerfeld (1892) and others have worked efficiently in this direction. On the other hand, J. J. Thomson (1891, et seq.), with remarkable intuition, affirms the concrete physical existence of Faraday tubes of force, and from this hypothesis reaches many of his brilliant predictions on the nature of matter.

As a final commentary on all these divers interpretations, the important dictum of

Poincaré should not be forgotten: If, says Poincaré, compatibly with the principle of the conservation of energy and of least action, any single ether mechanism is a possibility, there must at the same time be an infinity of others.

THE ELECTRONIC THEORY.

The splendid triumph of the electronic theory is quite of recent date, although Davy discovered the electric arc in 1821 and although many experiments were made on the conduction of gases by Faraday (1838), Riess, Gassiot (1858, et seq.) and others. The marvelous progress which the subject has made begins with the observations of the properties of the cathode ray by Plücker and Hittorf (1868), brilliantly substantiated and extended later by Crookes (1879). Hertz (1892) and more specifically Lenard (1894) observed the passage of the cathode rays into the atmosphere. Perrin (1895) showed them to be negatively charged, Röntgen (1895) shattered them against a solid obstacle generating the X-ray. Goldstein (1886) discovered the anodal rays.

Schuster's (1890) original determination of the charge carried by the ion per gram was soon followed by others utilizing both the electrostatic and the magnetic deviation of the cathode torrent and by Lorentz (1895) using the Zeeman effect. J. J. Thomson (1898) succeeded in measuring the charge per corpuscle and its mass, and the velocities following Thomson (1897) and Wiechert (1899), are known under most varied conditions.

But all this rapid advance, remarkable in itself, became startlingly so when viewed correlatively with the new phenomena of radioactivity, discovered by Becquerel (1896), wonderfully developed by M. and Madame Curie (1898, et seq.), by J. J. Thomson and his pupils, particularly by Rutherford (1899, et seq.). From the Curies came radium (1898) and the thermal effect of radioactivity (1903), from Thomson much of the philosophical prevision which revealed the lines of simplicity and order in a bewildering chaos of facts, and from Rutherford the brilliant demonstration of atomic disintegration (1903) which has become the immediate trust of the twentieth century. Even if the ultimate significance of such profound researches as Larmor's (1891) 'Ether and Matter' can not yet be discerned, the evidences of the transmutation of matter are assured, and it is with these that the century will immediately have to reckon.

The physical manifestations accompanying the breakdown of atomic structure, astoundingly varied as these prove to be, assume fundamental importance when it appears that the ultimate issue involved is nothing less than a complete reconstruction of dynamics on an electromagnetic basis. It is now confidently affirmed that the mass of the electron is wholly of the nature of electromagnetic inertia, and hence, as Abraham (1902), utilizing Kaufmann's data (1902) on the increase of electromagnetic mass with the velocity of the corpuscle, has shown, the Lagrangian equations of motion may be recast in an electromagnetic form. This profound question has been approached independently by two lines of argument, one beginning with Heaviside (1889), who seems to have been the first to compute the magnetic energy of the electron, J. J. Thomson (1891, 1893), Morton (1896), Searle (1896), Sutherland (1899); the other with H. A. Lorentz (1895), Wiechert (1898, 1899), Des Coudres (1900), Drude (1900), Poincaré (1900), Kaufmann (1901), Abraham (1902). Not only does this new electronic tendency in physics give an acceptable account of heat, light, the X-ray, etc., but of the Lagrangian function and of Newton's laws.

Thus it appears even in the present necessarily superficial summary of the progress of physics within one hundred years, that, curiously enough, just as the nineteenth century began with dynamics and closed with electricity, so the twentieth century begins anew with dynamics to reach a goal the magnitude of which the human mind can only await with awe. If no Lagrange stands toweringly at the threshold of the era now fully begun, superior workmen abound in continually increasing numbers, endowed with insight, adroitness, audacity and resources, in a way far transcending the early visions of the wonderful century which has just closed.

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SCIENTIFIC BOOKS.

Civil Engineering, A Text-book for a Short Course. By Lieut.-Col. G. J. FIEBERGER, U. S. Army, Professor of Engineering, U. S. Military Academy, M. Am. Soc. C. E.

It is not easy to rate the book under discussion at its true value. The tendency of engineering education of the present day is towards elaborate presentation of the several phases of engineering practise and if there is any reaction from the excessive development of so-called specialties, it shows itself in a greater concentration on elementary mechanics and other fundamentals.

When engineering education was in its infancy and when the science was being formulated, Rankine, in his famous and classic book, developed and put together all that was known on the subject. Since then, the science and knowledge of engineering have grown so rapidly and extensively that, in spite of a generous appreciation of the work of Rankine, one is startled at a present-day attempt to compress modern engineering knowledge into a single volume of less than six hundred pages.

The author explains that the book is intended to give the military cadets, who have to master many sciences and languages as well as military science and tactics, an elementary knowledge of civil engineering. To properly rate the value of the book, for its avowed purpose, this condition must be kept in mind and any comparison with other separate volumes, used in technical schools, must be carefully avoided.

About one third of the book is devoted to the mechanics of materials, and all ordinary problems of strength in flexure, tension, compression and torsion are given. Fifty numerical problems, about one to every four pages, are given to fix the principles stated, and additional illustrative problems are said to be used in the class room.

Thirty-four pages are given to hydraulics and seventy pages to bridge stresses, making one half of the book devoted to fundamental theory. While this theory is admirably presented, the principles and hypotheses carefully stated, however condensed, the writer can not help feeling that the average student mind is too immature to successfully assimilate such highly concentrated food, and further, he believes that much fundamental theory has been omitted. For example, in hydraulics no problems involving the time of emptying locks or reservoirs are given, no formulæ for velocity of approach for weirs and no discussion of submerged weirs. Yet space is taken for full algebraic development of equations of moment for continuous beams over four and even five supports.

Materials of construction, stone, cement, steel, iron, etc., are discussed to the extent of sixty pages. It is surprising, in view of the thousands of tons of Bessemer steel used annually in buildings, to read that 'open hearth steel is preferred by engineers for structural work,' while 'Bessemer steel is largely used for steel railway rails,' and further that 'cast-iron struts in the form of hollow columns are employed in structures not subjected to the shocks of suddenly applied loads.' In the description of brick, but ten lines are devoted to paving brick and the young officers are there told that paving brick are tested in a rattler used for castings or by dropping the brick repeatedly on a hard floor. It would have required so few additional lines to have

given the dimensions of the standard rattler, the standard charge and the percentage loss of good approved brick, that the omission seems strange.

The second half of the book is devoted to engineering construction proper, to foundations, the discussion of which is particularly good, to bridges (thirty-nine pages), to highways, to water supply and sewerage. These subjects are necessarily but briefly taken up and probably no two educators, in carrying out the difficult task of presenting only the essentials, would agree on what should be excluded. It is, therefore, futile to compare these chapters with those of other authors or to weigh the values of the separate paragraphs of the present book. The lists of text-books given at the end of each chapter serve to refer the young officers, at need, to the proper sources of information and are a most important part of the book. H. N. Ogden.

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Morphology and Anthropology, a Handbook for Students. By W. L. H. Duckworth, M.A., University Lecturer on Physical Anthropology, etc. Cambridge, at the University Press, 1904. The Macmillan Company. $4.50 net.

This is a very good hand-book for the use of students, containing a great deal in moderate compass. It makes little pretense to be anything more than a compilation, except in so far as the author gives us the benefit of his own judgment on disputed points. To present a compilation so as to be most available is a task of more than average difficulty. We think the author has in this been very successful. He first considers man's position in the animal series in the light of comparative anatomy; which implies a general review of the anatomy of the primates. Special attention is devoted to certain parts, especially the skull and the teeth. The presentation of the various views concerning the latter is particularly interesting.

We quote the words with which the second section of the book opens as the simplest way of showing the author's plan:

> The foregoing chapters have as their aim the demonstration of the fact that man is associated in a natural zoological classification with certain other mammals of the order Primates. It is now suitable to take up the second subject proposed for consideration in these notes, and to endeavor to ascertain something of man's ancestral history, that is, of the path of evolution traced by man. The means available for carrying out this enquiry are, in the present day, threefold: (1) Embryology, (2) comparative morphology of the various human races, and (3) paleontology.

The book then continues on these lines. The author introduces the embryological portion with the remark that its importance depends on the generalization that ontology repeats phylogeny. Since this book appeared this generalization has received a severe blow by Bardeen's researches on the development of the human spine, and, indeed, the author is ready to point out facts which do not agree with it. Long ago Marshall remarked that the record was a very imperfect one. It may now be questioned whether it will serve even as a working hypothesis. Be this as it may, Duckworth's observations strike us in the main very favorably, as both candid and judicious. It is not necessary to follow his work in detail.

We have purposely avoided the section on variations, not because we do not like it, but because the discussion would carry us too far. We will say in passing that the author does not seem to have freed himself from the widespread error, fostered by writers of the class of Wiedersheim and Testut, that resemblance is evidence of relationship. This slipshod method of thought has been so long condoned by those who should have been outspoken that it is doubly pleasant to read Osborn's address on the 'Present Problems of Paleontology.' Though our present author does not seem, as we have said, to have freed himself from this delusion, yet one suspects that he does not feel quite comfortable in its meshes. The reader will find in this part of the book a very convenient account of many methods used in practical anthropology.

A considerable part of the division of paleontology is given to the discussion of the

Trinil remains. This is very interesting. The author gives us the names of the three groups of anatomists who consider the remains human, simian and intermediate, respectively. The first group is essentially English, the second German and the third composite. Duckworth joins the last group, though admitting that the femur may be human. It is unfortunate that, having given so much space to this interesting question, he has not discussed the evidence that the pieces belong to one individual.

There are many other points which it would be interesting, at least to your reviewer, to discuss at length; but enough has probably been said to show that in his opinion it is a very good and useful hand-book.

T. D.

SCIENTIFIC JOURNALS AND ARTICLES.

THE September issue of the *Journal of Comparative Neurology and Psychology* contains the following articles: 'A Study of the Functions of Different Parts of the Frog's Brain,' by Wilhelm Loeser. The brain was experimentally examined by the extirpation of various regions (twenty-two operations) and study of the deficiency phenomena and other symptoms. 'The Central Gustatory Paths in the Brains of Bony Fishes,' by C. Judson Herrick. This paper (which was awarded the Cartwright prize for this year) is a continuation of the author's previous studies on nerve components, in course of which the peripheral gustatory system has been isolated and experimentally studied in fishes. Selecting the types in which this system attains its maximum development, the central gustatory paths are demonstrated by various microscopical methods, the research including a description, accompanied by forty figures, of the conduction paths for all of the important gustatory reactions which have been experimentally observed in the normal life of these fishes. The central gustatory centers are found to be more closely related to the central olfactory system than to any other part of the brain.

PROFESSOR FRANK SMITH, of the University of Illinois, has been made zoological editor of *School Science and Mathematics*. The biological section, of which Professor Caldwell was formerly editor, has been divided into two sections, a zoological section and a botanical section. Professor Caldwell remains the botanical editor.

DISCUSSION AND CORRESPONDENCE.

THE LETTER K IN ZOOLOGICAL NOMENCLATURE.

THERE are some influential zoologists who, in their zeal for the integrity of scientific Latin (or Neolatin), propose to change the letters k and w, wherever they occur, into c and v. Thus Sir G. F. Hampson, in his great work on the moths of the world, cites a species as *Episilia voccei*, the specific name being a new rendering of *wockei*, originally proposed by Moeschler. Unfortunately, this method results in some unexpected duplication of names. Thus Gray, in 1846, applied the generic name *Kogia* to the pygmy sperm whale. Butler, in 1870, used *Cogia* for a valid genus of butterflies, which is recognized to-day by Dr. Dyar as occurring in our own fauna. Now Dr. D. G. Elliot, in a recent work, amends the name of the whale to *Cogia*, and if this is accepted the name of the butterfly-genus must fall. It is true that Elliot's *Cogia* is later than Butler's, but it is proposed as the correct way of spelling Gray's genus, and not intended in any sense as a new name.

Theobald has lately proposed *Cellia* as the name of a genus of mosquitoes. But in 1822 Turton named a valid genus of mollusca *Kellia*. According to the Hampson-Elliot method this becomes *Cellia*, and the mosquito-genus name is a homonym.

Kallima was proposed by Westwood in 1850 as the name of a well-known genus of butterflies. In 1860 Clemens named a valid genus of moths *Callima*. Now Dr. Dyar, because of *Kallima*, has named the moth genus *Epicallima*.

Again, *Cnephasia*, Curtis, interferes with *Knephasia*, Tepper.

A curious case occurs in a genus of African moths, *Xanthospilopteryx*. In 1893 Carpenter named a species *X. kirbyi*, but it is a synonym of *pardalina*, Walker. In 1897 Holland

named another *X. kirbyi*, but this is a homonym, as the rules are generally understood. Hampson calls Holland's species *X. cirbyi*, and it is imaginable that this might be interpreted as the necessary new name for the insect. Since, however, it is only intended as a new way of writing the old name, it seems that Holland's insect should be renamed, say, *X. hollandi.*

Enough has been said to show that the proposed abandonment of k and w, if it is not to prevail, should be checked as soon as possible; or if it is to be the rule, should be widely known, so that proposers of new names may guide themselves accordingly. Personally, I am totally opposed to it, on the ground that names are merely symbols designating particular objects, and the most we can ask is that they have a Latinoid ending, and are not too long. Nevertheless, the matter is at present an open one, and if most zoologists prefer to follow Hampson and Elliot, the minority will probably give in to their wishes, for the sake of uniformity. On the other hand, if nearly all are against the proposal, it would seem that a few should not persist in making such changes as those cited, unless they can convince themselves that a very important matter of principle is involved.

If the editor will allow it, I will herewith ask all working zoologists who are willing to take the trouble to send me a post-card voting for or against the substitution of c and v for k and w, and I will list the names and send them for publication in SCIENCE. I think that the names should be published, for several rather obvious reasons, not the mere numbers pro and con.

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'HAMMOCK,' 'HOMMOCK' OR 'HUMMOCK'?

SOME recent botanical papers seem to indicate that there is still some uncertainty as to which of the above is the proper designation for a certain class of geographical features of frequent occurrence in some parts of the southeastern United States. These three words may represent three totally different and independent ideas, but they are so similar in spelling that one may be easily transformed into another by a mere typographical error. But typographical errors will not account for all cases, and there are certain other circumstances which complicate the problem. Having given the matter considerable study lately, both in field and library, I can present some observations which should clear up most of the existing confusion.

The lexicographers all seem to favor 'hummock.' Webster, for instance, says: "Hummock (probably an Indian word). (1) A rounded knoll or hillock; * * * (2) A ridge or pile of ice * * *. See Hommock. (3) Timbered land. (Florida.)" Under 'hommock' is the following definition: "Hommock (written also hammock and hummock). (Probably an Indian word.) A hillock, or small eminence of a conical form, sometimes covered with trees. *Bartram.*" The definitions in the Century and Standard dictionaries are somewhat longer, but do not differ materially from that of Webster, except that they say that hummock is probably a diminutive of hump. In all three, Bartram is the only authority cited for 'hommock'; and this word occurs on pages 31, 219–221, and perhaps elsewhere in the 1794 edition of his 'Travels.' The same spelling is used throughout Dr. E. W. Hilgard's 'Report on the Geology and Agriculture of Mississippi,' published in 1860, and in that work several varieties of 'hommocks' are fully described. Dr. Hilgrade in a recent letter informs me that that spelling was in accordance with the pronunciation used by the natives, but that he now believes 'hammock' to be correct, and writes it that way.

The published references to 'hammock' and 'hummock' are so numerous that it would be impracticable to attempt to list them; but thus far I have noted the former in at least thirty different books and papers, the earliest dating back to 1839, and the latter in about half as many, beginning with 1834. Most of the occurrences of both forms are in works dealing with Florida, and a careful search through Florida literature would doubtless reveal many other cases of each. It is

very significant in this connection that most of the writers who use 'hammock' have spent much more time in the regions they describe than have those who use 'hummock'; also that some who preferred the latter have expressly stated that the natives always pronounced it 'hammock,' and yet their faith in the dictionaries seems to have been too firm to be shaken by this indisputable evidence. In some cases it is almost certain that 'hummock' was put in by the editor or printer, without the sanction of the author,[1] though I have indeed noticed one or two cases where the same may be said of 'hammock.'

As far as my experience in the field goes, the natives in Georgia invariably say 'hammock.' I have heard this word in the counties of Chatham, Coffee, Lowndes, Pulaski, Tattnall and Wilcox, and it is doubtless used throughout the intervening ones. If any further evidence were needed, a good map will show a Gulf Hammock (also a post-office of that name) and a Hammock Creek in Florida, and a Hammock Island in Georgia. I have never yet seen 'hummock' on a map though, nor found any evidence that it is ever used in conversation anywhere (in the sense here indicated). As usage fixes the language, it follows that 'hammock' is the correct form.

Now as for the definition of this word. It is used for quite a variety of conditions, but from all the evidence obtainable it may be defined broadly as a limited area, with comparatively dry soil (at least never inundated, and thus distinguished from a swamp), containing a large proportion of trees other than pines, and located in a region where 'prairies,' marshes or open pine forests predominate. Topographically a hammock may be either a slight elevation, or a depression, or a slope, and its soil may be sandy, clayey or rocky. The soil is usually rather rich, and the trees growing in it are usually mostly evergreens—though there is probably no one tree which characterizes all hammocks—and they usually grow so close together as to shade the ground and allow the formation of humus, which is almost wanting in adjacent areas.

A few varieties of hammocks may be briefly mentioned. On the coast of South Carolina and Georgia, at least in the vicinity of Savannah, a hammock is a low sandy island in a salt marsh, conspicuous for its dense growth of evergreen woody plants; and in the Everglades of Florida, according to the accounts of several different explorers, it is a sort of rocky oasis, elevated a few inches above the adjacent prairies, and densely wooded. For these two kinds of places the term 'hummock' (diminutive of hump) would not be altogether inappropriate, and this fact doubtless accounts for some of the confusion above mentioned. But in central Florida, by all accounts, it seems that a hammock is usually a depression; while in the interior of the coastal plain of Georgia it is nearly always a sandy slope forming an intermediate zone between the river or creek swamps and the sand-hills which border them.

The published references to the subject show hammocks to range from North Carolina to Florida and Mississippi,[2] and, like many other interesting things, they seem to be strictly confined to the coastal plain. The natives of other parts of the country seem to have no knowledge of such a word, and as no lexicographers, and few writers of any kind, live in the regions where hammocks occur, it is not surprising that this word should be incorrectly treated in all dictionaries.

As for the etymology of 'hammock' (in this geographical sense) I have no suggestions to offer, other than that given by Webster for 'hommock' and 'hummock.' As a hammock as here defined is always characterized by its vegetation rather than by its topography, it can hardly have anything to do with 'hum-

[1] A case of this kind has occurred in the columns of SCIENCE since the above lines were written and sent to the editor. In the issue of June 16, in the report of a paper I read before the Torrey Botanical Club in April, I am made to say 'hummocks' instead of 'hammocks.'

[2] In a paper published by Dr. Arthur Hollick about twenty-five years ago (*Bull. Torr. Bot. Club*, 7: 14, 1880) there is a reference to a 'hammock of soapstone and iron ore' on Staten Island, which looks like a surprising extension of range; but Dr. Hollick tells me that 'hummock' is what he intended to say.

mock,' if that is a diminutive of hump, as seems most likely. Whether there is any connection between our hammock and 'hammock' in the ordinary sense (German *Hangematte*) perhaps some philologist can tell us. If 'hommock' could be universally adopted by the natives of the southeastern coastal plain, then 'hammock' could be restricted to the familiar manufactured article and 'hummock' to a heap of ice or something of that sort; but this is obviously out of the question at present.

Before dismissing the subject I should like to suggest to those botanists who believe in giving names of classical derivation to every kind of plant-habitat, that they find a Latin or Greek equivalent for the word under discussion, and thus do away with all this uncertainty at one stroke, at least as far as botanists are concerned.

Roland M. Harper.

College Point, New York,
June, 1905.

INDIAN BONE COMBS.

To the Editor of Science: Some of your readers may receive the valuable archeological reports of David Boyle, of Toronto, annually made to the minister of education, Ontario. Mr. Boyle fully believes that the bone combs found on Indian sites in Canada and New York are a purely aboriginal idea, while I as firmly hold that this idea came from Europeans. Such differences are common and natural, but the report for 1904 mistakes my position saying:

> The contention of Dr. Beauchamp is simply this, that without metallic tools it was impossible to make a comb, and the inference is that before the appearance of Europeans, the Indians had no use for any article of this kind.

The latter statement is correct, the former an error of my valued friend. If I have made such a statement I gladly retract it. I certainly do not believe this impossible in a general way, but metallic tools were used in most cases.

I have figures of forty-five of these combs from Iroquois sites in New York and they are found there on no others as yet. Ten of these are from Mohawk sites, found with glass and brass ornaments, and there are others there. Four are from Cayuga sites of similar character. Onondaga sites have furnished seven, of which two are as early as 1600. Seneca sites have furnished twenty, mostly made about 1687, with two more which are in a sense prehistoric. Some recent ones have not been figured. From Oneida sites I remember none, though they should occur there. Two others were from Jefferson County, where they are certainly rare. One of these may be classed as early and the other recent. Some brass beads found on sites there now place these in the sixteenth century, as had been surmised. Of those enumerated forty were found with European articles, and five may be dated anywhere from 1550 to 1600. The earlier and ruder ones were made with stone tools; the more elaborate with metallic implements. The soundness of my position will thus be seen. All known New York combs of this character seem to have been made between 1550 and 1700, and may be ascribed to European contact. A few were made with stone tools, soon replaced with those of metal, and I certainly do not think it was impossible to have made the ruder forms without the later tools. Why the Indians did not think of these combs before we can not tell. It is evident they did not till after European contact.

Some of the later combs are fine in design, and Mr. Boyle has given some figures of Egyptian bone combs, furnished by Wm. Flinders Petrie, and there are curious resemblances to those found in New York and Canada, so many centuries later. One great value of Mr. Boyle's reports to those laboring in New York is in the close relations of the fields, so well shown in his long and accurate work.

W. M. Beauchamp.

Syracuse, N. Y.,
August 11, 1905.

SPECIAL ARTICLES.

THE SYSTEMATIC NAME OF THE JAPANESE DEER.

That an author himself has no more right to change a systematic name once given by him than any other person is a principle now

accepted by all codes of zoological nomenclature.

In a preliminary introduction to the Fauna japonica entitled 'Coup d'œil sur la faune des îles de la Sonde et de l'empire du Japon,' published in 1837, and issued in the fourth fascicule of the work, which also contained the Japanese snakes, Temminck briefly diagnosed the Japanese deer, on p. xxii, as a new species under the name of *Cervus nippon*. In 1844, seven years later, in the second decade of the mammals of the same work, a plate illustrating this deer was published as *Cervus sika*. The text describing it more in detail under the latter name did not appear until many years later, probably not until 1852 or 1853. The diagnostic features given are essentially the same as indicated in the preliminary discourse of 1837.

The Japanese deer must, therefore, in the future stand as *Cervus nippon* Temminck.

LEONHARD STEJNEGER.
U. S. NATIONAL MUSEUM,
September 7, 1905.

THE POSSIBILITY OF ABSORPTION BY HUMAN BEINGS OF NITROGEN FROM THE ATMOSPHERE.

THE physiological value of nitrogen is to provide the staging or framework for the support and functional efficiency of the construction and nutritive processes at work in the living animal organism. The absorption of nitrogen by the animal organism has lately been regarded as resulting from the intermediary action of the vegetable world—a mode of nature-economy which there would be no reason for limiting to compounds of nitrogen, but should be extended to the entire range of animal-mineral absorption.

From this point of view, which seems to be based on close scientific observation, there has lately been extended a good deal of apparently well-qualified criticism with regard to the efficacy of the animal body-tissue to absorb and assimilate drugs derived from the mineral kingdom. Thus the administering of iron, strychnine, arsenic and other mineral tonics has been vigorously and justly condemned, not only by lay students, but also by the more advanced students in the medical profession themselves.

Yet, in the light of still more recent researches, it has been ascertained that the true reason for condemning certain drug medication does not lie in the assumed failure of the mineral compound to yield to absorption, but rather in the fact that such absorption is really possible. For, while the power of the mineral to generate changes in the animal organism largely proceeds on a mechanical basis, the fact remains that the changes wrought, let us say, by arsenic in the hemoglobin of the blood can be rationally explained only by admitting an action due to processes of physiological chemistry.

To discover the character of the forces and conditions at work in these processes of absorption has recently been the aim of some eminent French and German scientists. Thus, in his extensive studies of the character and genesis of nitrifying bacteria, Dr. Wohltman, of the Agricultural Institute in Bonn-Popelsdorff, Germany, has brought to light some highly interesting points with regard to the relations existing between nitrogenous compounds and organic substances. Among other observations he has found that the action of certain bacteria, hitherto considered indispensable in the elaboration of the nitrogen molecule for its absorption by the vegetable, is so only under certain conditions. In his 300 experiments with the soil in the valley of the Rhine, Dr. Wohltman ascertained that wherever the soil is rich in nitrogenous fertilizers, preferably ammonium nitrate, the leguminous plants are found to grow and absorb nitrogen without the presence of bacteria. From this fact Dr. Wohltman draws the conclusion that the 'association of the plants with the bacteria is not a necessity, but an expedient, and whenever there is a rich supply of nitrogenous elements in the soil, they (the plants) dispense with the bacteria and with the free nitrogen, which the latter make available, by directly secreting it from the chemical combination of soil or air in which it is held suspended.'

From this fact, it would certainly be justifiable to draw the inference, that whatever

under given conditions is available to the vegetable organism, may also, under corresponding conditions, be within the power of the animal organism. And as the intermediary action of the bacteria has its basis in 'expediency' rather than in necessity, it follows that nature can dispense with any process, when ends of higher evolutionary order are aimed at. Hence, she recognizes no immutably fixed ways of procedure, but manifests everywhere along the lines of least resistance, using methods which, for the time being, conform closest to the most advantageous conditions. Nor are there to be found any organically or physiologically interposed impassable barriers between the various kingdoms of nature. Therefore, if the animal kingdom is evolved from the vegetable, there can be no power of function or assimilation in the latter, which is not also present—though perhaps latent—in the former. The larger must necessarily in itself contain the lesser, as a function or equality, once evolved, is forever retained in the subsequent output of a similar evolution; while at the same time continually increasing in strength and complexity. Hence, whenever 'expediency' demands the functioning in an entity of a certain power, the latter will make its appearance on the field of evolution though conditioned by natural environments.

Through his painstaking experiments, Dr. Wohltman has shown that in the absence of the specific bacteria, the plant organism has proceeded to exercise unsuspected functional powers. That similar powers, under corresponding conditions, may be called into action in the animal organism, can not reasonably be doubted, and the absence of 'free nitrogen' in the animal system, *i. e.*, the reduction of nitrogenous tissue caused by a longer or shorter abstinence from food, may probably bring about such conditions. Of course, on the other hand, the circumstance must not be lost sight of that, even if the proper conditions have been present, the evolution of the great majority of individuals may not yet have reached a stage of development where the inherent powers of their nature are adequate to an immediate response to the call. Hence, the utilization of this great physiological fact must be preceded by a self-conscious recognition and appreciation of the evolutionary possibility of the process. That in course of physical and mental unfoldment, the individual shall be able to absorb his nitrogenous needs directly from the atmospheric air, we have, in view of the above facts, no true reason for doubting.

In the journey through natural evolution we are met by neither air-tight nor life-tight compartments. To their origin and essence all forms are identical; and a rising French scientist, Dr. Barière of Lyons, has arrived at the position that this identity of the entities of evolution extends not only to the character of origin, but also to the place of origin. According to him, the cradle in which life found its first receptacle was rocked by the waves of the ocean, or, in the words of the old account of Genesis which the doctor quotes—not in support of, but as a case of curious coincidence with, his theory: "The spirit of God moved upon the face of the waters." "It" (the primitive life), Dr. Barière continues, "sprang from the single cell, which constitutes practically the same manifestation of forces to-day as in a hypothetical dawn of existence. And in the bodies of all plants and animals the cells are continually bathed in a fluid, which, whether lymph, blood, or vegetable sap, differs in no essential way in its composition from sea water."

But more than this, the crystal itself has yielded up its secret to the scrutinous search of science, and confessed to a possession of the same powers of absorption as found in the kingdoms above it. At the special stage in the formation of crystals when they are found to collect themselves from their saline solutions into concrete substance, they seem to behave like sentient beings, governed in their movements by orderly purposes. In this intermediate stage between solution and crystalline fixity they exhibit all the characteristics of complete cell life, with cell-wall, nucleus, nucleoli and granulated cell body, while all throughout the transformation they show a very marked self-adjusting activity.

This fact would make it appear very prob-

able that the genesis of the single cell, whether passing into crystalline fixity or organizing into higher forms of life, points to the same place of origin—the salt sea—where the microscopic entity at the very outset is surrounded by large quantities of organic nitrates. Hence, the power of absorbing nitrogen would constitute the first and mutual condition for any order of cellular existence, organic or crystalline. And, as the evolution of the organic structure proceeds through and by the inorganic, it follows that the native powers of the mineral cell—of which nitrogenous absorption constitutes one—are all transmitted to the subsequent cell structures of vegetable and animal life.

On the basis of the experiments and investigations referred to in this article, there seems to be nothing either unreasonable or unscientific in the theory that the human being, under certain conditions, possesses the power of assimilating nitrogenous compounds in his vital economy without the assistance of an intervening vegetable kingdom.

AXEL EMIL GIBSON.
LOS ANGELES, CAL.

QUOTATIONS.

MR. J. B. BURKE'S EXPERIMENTS.

MR. BURKE made use of solid radium bromide in fine powder. He sprinkled a few minute grains on a gelatine broth medium, possibly somewhat soft, so that the granules would sink slowly below the surface. Once there they would dissolve in and decompose the water, liberating oxygen and hydrogen, together with emanations, which would remain mixed with these gases. The gases would form minute bubbles, probably of microscopic dimensions, and the coagulating action of the emanation on the albumen of the liquor would surround each with a skin, so that the product would appear like a cell; its contents, however, would be gas, or, rather, a mixture of the gases oxygen and hydrogen. The emanation, enclosed in such a sack, would still decompose water, for enough would diffuse through the walls of the sack, which, moreover, would naturally be moist. The accumulation of more gas would almost certainly burst the walls of the cell, and almost equally certainly in one or two places. Through the cracks more gas would issue, carrying with it the emanation, and with it the property of coagulating the walls of a fresh cell. The result of the original bubble would resemble a yeast cell, and the second cell a bud, or perhaps more than one, if the original cell happened to burst. This process would necessarily be repeated as long as the radium continued to evolve emanation, which would be for the best part of a thousand years. The 'life,' therefore, would be a long one, and the 'budding' would impress itself on an observer as equally continuous with that of a living organism.

I am surprised to learn from Mr. Burke's first letter that the 'organisms' appear to dissolve in water. The emanation does not coagulate or apparently affect gelatine, for I have tried and found that it does not; indeed, it was not to be expected. Is it possible that the gelatine is pushed away to form the cell-wall, leaving the albumen as a partial content of the cell, along with gas? The latter would, doubtless, diffuse through the cell-wall of coagulated albumen and dissolve in and mix up with the water. On placing the apparent 'organism' in water the gelatine, too, would be extracted, and the cell would seem to disappear, the wall being excessively thin. It would be interesting to learn if Mr. Burke has attempted to stain his 'organisms' with the usual dyes used by microscopists. It is possible that the coagulated albumen would take the stain better than the uncoagulated matter and that the structure would thus be revealed.

As I said before, I have no desire to dogmatize. The supposition that the pouring of energy in some form into matter similar to that of which living organisms are made, and which serves as sufficient food for actual living organisms, might conceivably result in the production of life, is a very attractive one. But one is bound to sceptical, and the explanation which I have ventured to suggest appears to me to be sufficient to meet the case. But no one will rejoice more than I if it should ultimately prove to be inadequate.—Sir William Ramsay in *The Independent*.

THE CHICAGO DEATH-RATE.

A violent difference of opinion existed in 1900 between the Chicago Health Department and the Census Bureau. The census authorities credited Chicago with a population of 1,698,753, while Chicago claimed, and estimated her death-rate on, a population nearly a quarter million greater. The census bureau said, moreover, that Chicago had made the opposite error in counting her deaths. The census enumerators turned in 1,930 deaths, which were not accounted for in the returns of the City Health Department. Thus it appeared that Chicago had made a plus error of 15 per cent. in estimating her population and a minus error of 6 per cent in counting the deaths. The Census Bureau said that the 1900 death-rate of Chicago was 16.2 per 1,000. In the very next year, 1901, Chicago published her famous low death-rate of 13.88, which, Dr. Whalen says, this year's death-rate will surpass. Of course, the death-rate for 1901 was discredited. The statement that 1901 was a remarkably healthy year throughout the world did not remove the doubt which the census results had thrown on Chicago's vital statistics. The department itself later yielded the point of population and accepted the census figures. The discrepancy in the mortality was allowed to slumber and Chicago offered no satisfactory explanation of the 1,930 death records which the enumerators turned in and which the Census Bureau added to the records furnished the Health Department of Chicago. It is well known that the census enumerators' returns of mortality are about 40 per cent. short. Since these returns are based on inquiry at every house concerning the deaths during a year preceding, the results can hardly be expected to exceed 60 per cent. of the deaths truly chargeable to the period. A comparison of the enumerators' returns in 1900 with the mortality returns furnished by the Health Department of Chicago (16,059 and 27,752) shows that the enumerators did not get quite 60 per cent. of the true returns. If, therefore, the 1,930 records appearing in the census schedules, but absent from the city returns, really belonged to Chicago's mortality for 1900, the indications are quite clear that the mortality upon which the Health Department based its death-rate was less than the true mortality by 3,216 deaths, and that Chicago was fairly chargeable with a death-rate in 1900 of 18.23 per 1,000, two points more than the census rate and about four points higher than the rate which Chicago published.

The suggestion of Dr. Whalen that New York inflates her population figures is not supported by an examination of the census reports, nor did the twelfth census indicate a short count of the New York mortality in 1900. The advantage gained by the recent census of New York (46,000 above the population estimated on the experience of the previous decade) is far too small to justify a suspicion of padding; but Dr. Whalen's suggestion that New York 'corrects' her mortality sheet by excluding all deaths of non-residents and all deaths of infants under two weeks, opens up a question of great importance in American mortality registration. There is no agreement among American registration offices as to the elements of mortality rates. The cities of this country are absolutely unanimous in the exclusion of non-resident decedents, unless Chicago counts them in. Only a few cities, however, publish statements of the non-resident mortality, and not one explains what is meant by a non-resident. It would help the cause of registration tremendously if New York would make public answer to Dr. Whalen's definite charges of unfairness, and if Chicago would also define her practise. Let us have from each city answers to the following questions: Are the deaths of non-residents, occurring in the city, included in the total mortality on which the death-rate is figured? Are the deaths of citizens, taking place outside the city, included in the death-rates? What rule determines the question of residence in cases of death within the city? What rule determines the question of residence in cases of death without the city? Is any part of the infant mortality excluded from the death-rates? Are stillbirths included in the total mortality? What definition of a stillbirth governs your registrar?
—*American Medicine.*

CURRENT NOTES ON METEOROLOGY.

MONTHLY WEATHER REVIEW.

RECENT numbers of the *Monthly Weather Review* have contained articles of general interest as follows:

No. 3, 1905; 'Application of Mathematics in Meteorology,' by Professor F. H. Bigelow. Reprinted from *Bull. Phil. Soc. Wash.*, Vol. 14, 1905, p. 215. Summary of the mathematical state of certain important meteorological problems. 'The Diurnal Periods of the Barometric Pressure,' by the same author. 'Tornado in Eastern Alabama, March 20, 1905,' by F. P. Chaffee. The usual phenomena accompanied this tornado. 'The Variations in Atmospheric Transparency during 1902, 1903 and 1904,' by H. H. Kimball. A comparison of some of the results obtained in the United States and in the Pyrenees. 'Twilight Glows and Connected Phenomena observed in 1902, 1903 and 1904, in the Pyrenees,' by E. Marchand. From the *Ann. Soc. Met. dè France,* February, 1905. This includes observations on the diminution of solar radiation. 'Tornado near Bluff Springs, Fla., March 20, 1905.'

No. 4, 1905: 'The Diurnal Periods of the Vapor Tension, the Electric Potential and Coefficient of Dissipation' and 'The Observations with Kites at the Blue Hill Observatory, 1897–1902,' by Professor F. H. Bigelow. 'Mathematical Theory of the Nocturnal Cooling of the Atmosphere,' by S. T. Tamura. A historical and critical survey of the problem of the nocturnal cooling of the atmosphere, and a mathematical theory of the nocturnal cooling of the atmosphere near the earth's surface. 'The Influence of Small Lakes on Local Temperature Conditions,' by James L. Bartlett. A study of the influence of Lakes Mendota and Monona, and of other smaller lakes, upon the climate of Madison, Wis. 'Wind Velocities for Different Altitudes and Exposures,' by A. J. Mitchell. Observations made at Jacksonville, Fla. The conclusion is that an increase in elevation of the anemometer cups of 50 to 60 feet results in an increase of approximately one mile per hour in the lower circulation at Jacksonville. 'Tornadoes of March 17, 1905, in Western Oklahoma,' by C. M. Strong. 'A Cold-Weather Dust Whirl,' by F. W. Proctor. A dust whirl at 11 A.M. March 13, 1905, over frozen ground, at Fairhaven, Mass. A very rare phenomenon. 'Note on the Winds of the Region adjacent to the Gulf of California,' by Professor George H. Stone. These winds come persistently from about south, and have a constancy which the author describes as monsoonal. 'A Heavy Deposit of Hoarfrost and its Effect in Retarding Nocturnal Cooling,' by D. A. Seeley. At Peoria, Ill., illustrated by a thermograph curve. A good example for use in teaching. 'Tornado of April 14, near Pensacola, Fla.,' by Wm. F. Reed, Jr. 'Meteorological Course at Williams College,' being part of a syllabus used in teaching. The course is unusually complete.

ISLANDS FOR PURPOSES OF WEATHER FORECASTING.

IN *Nature* for June 1, 1905, Dr. W. J. S. Lockyer points out the need of securing weather observations from islands to windward of the continents when possible, in order that the conditions which are approaching the lands from the sea may be known in advance. The value of wireless telegraph messages from vessels to the west of the British Isles; of reports from the West Indies to the United States; from Mauritius to India and to Africa; of Tristan d'Acunha to Africa, etc., is emphasized. It is pointed out that conditions at a great distance are important in determining seasonal weather of many countries. Thus the air current which passes the western coast of Australia in July later becomes the southeast trade of the Indian Ocean, and finally reaches India as the southwest monsoon.

METEOROLOGY AND OTHER SCIENCES.

CAPTAIN D. WILSON-BARKER, R.N.R., in his presidential address before the Royal Meteorological Society, London (*Quart. Journ. Roy. Met. Soc.*, April, 1905), spoke of 'The Connection of Meteorology with other Sciences,' pointed out that meteorology deserves much more attention than it receives, and expressed the wish that the subject might be taught in schools. 'The United States,' said Captain Wilson-Barker, 'have devoted much attention

to meteorology, with most satisfactory results.' One point in his address must commend itself to many persons who try to keep up with the progress that is being made along the various branches of meteorological science, and that is the plea for maintaining 'a comprehensive outlook on the whole field of investigation,' which is important in these days of intense specialization.

A NEW TEXT-BOOK OF METEOROLOGY.

THE June number of the *National Geographic Magazine* contains an article entitled 'Forecasting the Weather and Storms,' by Professor Willis L. Moore, chief of the Weather Bureau. This article occupies all but three pages of this number. It is illustrated by means of numerous weather maps, storm charts and half-tone prints, and is to form, as we learn, one chapter in a forthcoming book by Dr. Moore, entitled 'The New Meteorology.' The author's experience in the Weather Bureau, and the exceptional facilities at his command, will doubtless result in producing a popular book which will be very widely read.

NOTES.

AT a recent exhibition of meteorological instruments held under the auspices of the Royal Meteorological Society in London, one of the most interesting exhibits was a series of twenty-four-hour traces of continuous sunshine, obtained on the Antarctic expedition of the *Discovery*.

Consular Report for February, 1905, contains a report by the American consul at Nottingham, England, on the fogs of that district, their relation to commerce, business and health, and the suggestions that have been made regarding the dispelling of fogs.

A PAPER by Forel in the *Archives des Sciences physiques et naturelles* for March, 1905, summarizes the observations of Bishop's ring which followed the Mont Pelée eruption of May 8, 1902.

PROFESSOR ANGELO MOSSO (*Atti dei Lincei*, XIV., (1)), has made experiments on the effect of carbon dioxide as a remedy for mountain sickness, and recommends that about eight per cent. of CO_2 should be added to the compressed oxygen which is taken for use during high balloon ascents.

R. DE C. WARD.

NOTES ON INORGANIC CHEMISTRY.

SOLUTIONS IN LIQUID AMMONIA.

THE modern theories of solution are based almost exclusively upon phenomena taking place in aqueous solution. It is true that the action of other solvents, especially the organic, has been studied, as well as that of liquid ammonia, and to a lesser extent of liquid hydrogen chlorid, sulfid and fluorid. But this work has contributed little to the theory of solutions in general, nor have the theories of solution in water been to any considerable extent successfully applied to other solvents. During the past eight years Professor E. C. Franklin, now of Stanford University, has done much work on solutions in liquid ammonia, and in a recent *Journal* of the American Chemical Society he has brought forward a rather notable generalization, which brings the liquid ammonia solutions into line with water solutions. It has long been recognized that liquid ammonia stands near water as a solvent. It is an associated liquid with a fairly high dielectric constant. While inferior generally to water as a solvent, it has marked power of ionization, the more dilute ammonia solutions being even better conductors of electricity than aqueous solutions of the same concentration. As water from the standpoint of solution is to be looked upon as a compound of H ions and OH ions, so ammonia is a compound of H ions and NH_2 ions. When acids are dissolved in liquid ammonia they form, as a matter of course, ammonium salts, but nevertheless they retain true acid properties. They discharge the color of phenolphthalein; they dissolve metallic sodium and some other metals with the evolution of hydrogen and the formation of metallic salts; they dissolve certain metallic oxids and basic salts which are insoluble in the liquid ammonia. Here the acid ion seems to be not H, but NH_4, or as we may write it, $NH_3.H$. It is, however, by no means im-

possible that in aqueous acids we have present, not the ion H, but OH_3 or $OH_2 . H$. In each case the hydrogen ion would be associated with a molecule of the solvent. Besides these compounds which act as acids in water, there are other compounds not acids in aqueous solution, which act as acids in ammonia. Such, for example, are the acid amids and imids. In acetamid we may, perhaps, assume the ions CH_3CONH and H; in urea the ions H_2NCONH and H, as well as $CO(NH)_2$ and 2H. Here the NH seems to play the same part as the oxygen atom of the hydroxyl of acetic or carbamic acid. When sodium is dissolved in liquid ammonia, it gradually decomposes it with the evolution of hydrogen and the formation of sodium amid, $NaNH_2$. The reaction is of course exactly analogous to the action of sodium on water with the formation of sodium hydroxid, NaOH. The interesting point is that sodium amid in ammonia solution is a base, just as sodium hydroxid in water. It colors phenolphthalein and neutralizes the ammonia acids. Just as aqueous bases contain the OH ion, the ammonia bases contain the NH_2 ion. When the bases react upon acids in liquid ammonia, salts are formed, which may be precipitated when insoluble, or left as crystals on evaporating the ammonia. Thus the reaction between acetamid and potassium amid may be expressed as follows:

$$CH_3CONH . H + K . NH_2 = CH_3CONH . K + NH_3.$$

Salts of the strongly positive metals, as far as they are soluble, dissolve in ammonia as in water without change. Compounds of the negative elements are more or less completely hydrolyzed by water. The same compounds are 'ammonolyzed' by liquid ammonia. The analogy is shown by comparing the reactions:

$$AsCl_3 + 3H . OH = As(OH)_3 + 3HCl$$
$$AsCl_3 + 3H . NH_2 = As(NH_2)_3 + 3HCl,$$
$$(3HCl + 3NH_3 = 3NH_4Cl).$$

As the hydrolysis of $SnCl_4$ gives us not $Sn(OH)_4$ but $SnO(OH)_2$, so the ammonolysis of PCl_3 gives not $P(NH_2)_3$ but $P(NH)NH_2$, and of SiS_2 gives $Si(NH)_2$ rather than $Si(NH_2)_4$. As with hydrolysis so in ammonolysis the reaction need not go to completion. In such a case we have in aqueous solution the precipitation of basic salts, and so here also are formed ammono-basic salts, which may be more or less de-ammoniated and hence appear as amins, imins or even as nitrils, that is, nitrids. The reaction of the formation of these basic salts is, as would be expected, reversible, and they can, after precipitation, be carried back into solution by an excess of 'ammono-acid,' that is, by an ammonium salt. This method of treatment seems to clear up very satisfactorily the mercury-ammonia compounds which have for nearly three quarters of a century been a stumbling block to chemists. They here appear to be ammono-basic salts, or mixed hydro- and ammono-basic salts, occasionally with ammonia of crystallization. They thus fall completely in line with the many and more familiar hydro-basic compounds of mercury.

It is a large field which has thus been opened by Franklin, and one which will require much work, of great experimental difficulty, before it is satisfactorily worked over, but what has been already done has served to greatly broaden our knowledge of solutions.

J. L. H.

FIRST INTERNATIONAL CONGRESS OF ANATOMISTS.[1]

THE first meeting of the Congrès fédératif international d'Anatomie was held in Geneva, and commenced on the morning of Sunday, August 6, by the opening of an exhibition of specimens and appliances illustrating recent progress in anatomy. The congress closed on the evening of Thursday, August 10, when three hundred members and adherents of the congress were entertained by the city of Geneva at an official banquet. The congress represented a conjoint meeting of the five leading anatomical societies—the Anatomical Society of Great Britain and Ireland, Anatomische Gesellschaft, Association des Anatomistes, Association of American Anatomists and the Unione Zooligica Italiana.

[1] From *Nature*.

Almost every country was represented. Switzerland itself contributed more than 100 members, France 66, Germany and Austria 36, Great Britain and Colonies 23, Italy 11, America 3, and other countries 16. The largest contributors to the proceedings of the congress, however, were the Germans; out of a total of 117 communications, 32 were made by them, 31 by the French, 18 by the British, 15 by the Swiss, 8 by Italians, 5 by Swedes, and 2 by Americans.

From every point of view the congress was a success. Anatomy is peculiarly susceptible of international treatment, the subjects for description and discussion being concrete and capable of direct demonstration. The language difficulty certainly hindered a free discussion on more than one occasion; for instance, on the second day, a speaker, after giving his communication in French, listened most attentively to a vigorous criticism in German, and, bowing profoundly, replied, 'Je ne comprends pas l'allemand.' With an agenda list overloaded with 117 communications, there was a grave risk of disorganization. Thanks to the complete arrangements made by the committee of organization, presided over by Professor A. Êternod, of Geneva, and to the perfect arrangement of business by the president of the secrétariat, Professor von Bardeleben, the proceedings of the congress made an even and steady progress. The success of the congress must also be ascribed to Professor Nicholas, of Nancy, secretary of the French society; English members were indebted to Professor Symington, president of the British society, and to Dr. Christopher Addison, its secretary. Each day's work was divided into two parts; the morning was devoted to papers, ten minutes being allowed for each communication, and three minutes to any member who wished to criticize; the afternoon was set aside for exhibition of new specimens and demonstrations of the material on which the communications of the morning were based, and this was by far the most instructive and profitable part of the day's work. The Swiss cow-bell employed by the president of each day's proceedings (for the president of each society acted in turn as chairman) to warn the speaker that he had reached the limit of his allotted time, bound the members of the congress by a common sense of humor and materially aided the success of the meeting. In spite of the *entente cordiale*, the British anatomists associated more closely with the German than with the French members of the congress—an association determined, for the greater part, by the fact that the Germans were the superior linguists.

The members of the congress took part in the dedication of a monument to the memory of Professor Hermann Fol, who set sail from Havre in his yacht, *l'Aster*, in the spring of 1892 to investigate the fauna of the Mediterranean. From the day he sailed until now not a single trace has been discovered of ship or crew. The members of the congress were lavishly entertained by Madame Fol. The congress placed a wreath on the bust of the Swiss physiologist Servetus, who discovered the pulmonary circulation in the sixteenth century, and was burned at the stake by Calvin because, so it is said, he denied the existence of the Trinity. A wreath was placed by the British section of the congress on the spot where he was burned, this gracious act being prompted by Professor Dixon, of Trinity College, Dublin.

The congress was a social as well as a scientific success. An invitation from American anatomists to meet at Boston in 1907 was declined, as it was felt that at least a space of five years should intervene between each congress. A permanent committee for the organization of the next congress was formed by the nomination of five men, one from each of the five affiliated societies. It is intended to bring out a bulletin containing the proceedings and transactions of the congress, to which purpose part of the sum (11,000 francs) raised by subscription in Geneva to meet the expenses of the congress will be devoted. When it becomes the turn of London to entertain this congress, it will not be found an easy matter to attain the standard of hospitality which has been set by Geneva.

MAGNETIC AND ALLIED OBSERVATIONS DURING THE TOTAL SOLAR ECLIPSE OF AUGUST 30, 1905.

THE stations finally decided upon by the department of terrestrial magnetism of the Carnegie Institution of Washington in order to provide for the proper distribution and successful study of the subject under investigation were as follows:

Labrador: Battle Harbor (magnetograph, atmospheric electricity observations and declination eye-readings, the whole under the direction of J. E. Burbank, assisted by Messrs. Bowen and Homrighaus) and Turnavik (magnetic declination eye-readings by Mr. G. L. Hosmer, of the Massachusetts Institute of Technology). Both parties were supplied with full sets of absolute instruments with which important magnetic secular variation and magnetic distribution data will be obtained en route and returning. As the Canadian magnetic expedition, under the direction of Professor Stupart, located its station in Labrador within the belt of totality, the above stations were selected so as to have one immediately south of the belt and the other about the same distance north. Dr. W. G. Cady, of Wesleyan University, furthermore, made magnetic observations at Black Point, Nova Scotia, and Dr. L. A. Bauer, assisted by Professor W. C. Bauer, of Baker University, observed at Missinabi, Ontario, Canada.

In addition, Professors Elster, Geitel and Harms made atmospheric electricity observations at Palma, Majorca. It was also found that the department could avail itself of the skill and experience of Professor Palazzo, director of the meteorological and magnetic service of Italy, and so made arrangements for magnetic, electric and meteorological observations under his direction at Tripoli.

Observations were made under the auspices of the United States Coast and Geodetic Survey at Pembina, North Dakota, by Professor H. W. Fisk, of Fargo College; at Wausau, Wisconsin, by Mr. C. C. Craft; at Colebrook, New Hampshire, by Dr. G. B. Pegram, of Columbia University, and at the various magnetic observatories. At the Cheltenham Magnetic Observatory both special magnetic and electric observations were made under the direction of the observer-in-charge, Mr. W. F. Wallis.

At all of these stations the assigned program of work as published in SCIENCE was successfully carried out.

These stations in addition to those by other countries will afford a unique and most valuable collection of data covering the entire belt of totality. The hearty cooperation secured from foreign countries has been very gratifying, some of them going to considerable expense and pains. To cite but one instance, Russia in order to complete the distribution of stations along the belt of totality, sent under the auspices of the St. Petersburg Academy of Sciences, an expedition specially equipped for magnetic work and placed it under the direction of one of its most experienced magneticians, M. Dubinsky, in charge of the Pawlovsk Magnetic Observatory. Other European countries were no less zealous and likewise either sent special expeditions equipped for magnetic and electric work under the direction of able and experienced observers or made special arrangements for careful and comprehensive observations at their home stations.

According to the reports already received from observers in the United States and Canada, the eclipse interval was a rather disturbed one, due to a cosmic magnetic storm, the magnetic disturbances having in fact begun several days before the day of the eclipse. During the night of August 29 and 30, brilliant polar lights were visible at the northern stations.

At the writer's station (Missinabi, Canada, 48° 28'.6 N. and 5^h 33.9^m west of Greenwich) in addition to the disturbances already referred to, there was a smaller fluctuation about the time of maximum obscuration of the sun of the character and amount to be expected as the eclipse effect—as judged by previous eclipses. However, whether this particular fluctuation is really to be referred to the eclipse can not be stated definitely until the records have come in from other stations. If it is found that the characteristic features of

this fluctuation did not take place simultaneously at widely distant stations, but progressed in accordance with the passage of the shadow cone, the presumption will be strong that an eclipse effect has again been detected. A fuller announcement must be reserved for a later occasion.

L. A. Bauer.

Dept. Terrestrial Magnetism,
Carnegie Institution,
Washington, D. C.,
September 11, 1905.

A NATIONAL CONFERENCE OF TRUSTEES OF AMERICAN COLLEGES AND UNIVERSITIES.

A National Conference of Trustees of American Colleges and Universities will be held at the University of Illinois, Urbana, Illinois, beginning Tuesday, October 17, 1905. All trustees of such institutions and all persons who have served as trustees are cordially invited to attend.

The sessions will be held during the week in which Dr. Edmund J. James will be formally inaugurated as president of the University of Illinois. The members of the conference will be invited to attend the exercises connected with the inauguration. This will give the members of the conference an opportunity to meet representative men, presidents and professors, from many different institutions, who will be in attendance as delegates, and also to inspect the work of one of the larger of the state universities.

It is well known that the method of governing higher institutions of learning by boards of trustees, that is, bodies of non-experts—laymen, so to speak, in the field of education, —is peculiarly American.

In England the old universities are self-governing bodies, controlled largely by the faculties; in France and Germany they are departments of the government, and so far as they are not directly under the control of the government, they are autonomous, that is, ruled by the faculties. In the United States alone we felt it necessary to create a third organ, an independent, often self-renewing body of non-experts, in whose hands the entire legal control has usually been placed.

Many authorities regard this as a most satisfactory method; others find in it some of the most serious weaknesses of our American system of higher education; all believe that the problems connected with such a plan of control are far from being worked out satisfactorily.

This conference has been called for the purpose of discussing some of the most important questions of college and university administration, involving the relations of trustees, presidents and faculties. Among the questions which will be discussed are the following:

1. What should be the real administrative body of a college or university, the faculty or the trustees?

Should the trustees limit their functions to selecting a faculty and then vest in the latter the actual administration, or should the board itself undertake to administer the institution, either as a body or through its committees?

2. Should the president of the institution be the sole advisory authority to the board of trustees, or should the other administrative officers, or the various faculties, be consulted?

3. Should the faculty be authorized to nominate men to the board for vacancies, or should that be done by the president or by the committees, or by the members of the board?

4. How should trustees be selected? (*A*) By cooperation? (*B*) By the alumni? (*C*) By outside authority? (1) In case of private institutions, by the church or other body? (2) In case of state institutions: (*a*) Appointed by the governor? (*b*) Elected by the people? (*c*) Or *ex officio*, *e. g.*, governor, superintendent of public instruction, etc.?

5. Should the trustees assume entire control of the financial administration, or should they allow the faculties to have a representation also, by allowing them to submit a budget either by departments or as a whole?

6. Should the trustees, if they reserve the financial authority, undertake to determine the budget in all its details, or should they simply distribute by departments and leave it to the individual departments to make detailed distribution?

7. Should the trustees of all institutions, public and private alike, be required by law to file full financial statements with some public authority and publish the same?

8. Should the alumni have some formally recognized place in the scheme of government of the institution? If so, what?

9. Should the student body have formal recognition in the scheme of government by being privileged to appoint representatives to any disciplinary or administrative body?

10. Is it possible to devise uniform methods of bookkeeping and statistics, so as to make comparisons more valuable?

It will be seen that these are all vital questions, indicating difficulties which every board of trustees has to meet. It is believed that every university or college trustee will derive great aid in the performance of his duties by attending this conference and exchanging views on these important topics.

Urbana, in which the University of Illinois is located, forms with its adjoining city, Champaign, a single community of about twenty thousand inhabitants. It is situated 128 miles due south of Chicago, at the junction of three great railway systems, the Illinois Central, the Chicago, Cincinnati, Cleveland and St. Louis (Big Four), and the Wabash railways, and is thus easy of access from every direction.

Persons desiring to attend this conference should notify the undersigned as soon as possible. Suggestions as to other desirable topics for discussion will be thankfully received. Address:

David Kinley,
Dean of the College of Literature and Arts, University of Illinois,
Urbana, Illinois.

THE HARVEY SOCIETY.

The Harvey Society, described by its constitution as 'a society for the diffusion of the knowledge of the medical sciences,' offers the following course of lectures which are to be given under the patronage of the New York Academy of Medicine:

FIRST COURSE OF HARVEY SOCIETY LECTURES, 1905–1906.

October 7, Professor Hans Meyer, 'Die Theorie der Narcose' (in German).

October 14, Professor Carl von Noorden, 'Modern Problems of Metabolism.'

November 4, Professor F. G. Novy, 'Trypanosomes.'

November 18, Dr. P. A. Levene, 'Autolysis.'

January 20, Professor W. H. Park, 'A Critical Study of Serum Therapy.'

January 27, Professor Lewellys F. Barker, 'The Neurones.'

February 2, Professor F. S. Lee, 'Fatigue.'

February 9, Professor L. B. Mendel, 'The Formation of Uric Acid.'

February 16, Professor T. H. Morgan, 'The Extent and Limitations of the Power to Regenerate in Man and other Vertebrates.'

February 23, Professor Charles S. Minot, 'On the Nature and Cause of Old Age.'

March 2, Professor J. C. Webster, 'Modern Views regarding Placentation.'

March 9, Professor Theobald Smith, 'Some Phases of Tuberculosis.'

March 16, Professor W. H. Howell, 'The Cause of the Heart Beat.'

The lectures will be held in the Academy of Medicine at half past eight on the above evenings during the winter. In the Sorbonne at Paris courses of lectures by distinguished Frenchmen and men of other lands are given with the object of bringing science before those engaged in practise and art of various pursuits. The aim of the Harvey Society is similar in character. The Harvey Society cordially invites all interested to attend this course.

SCIENTIFIC NOTES AND NEWS.

Dr. W J McGee, U. S. Commissioner of the International Archeological and Ethnological Commission, lately chief of the department of anthropology and ethnology of the St. Louis Exposition and ethnologist in charge of the Bureau of American Ethnology, has been appointed managing director of the St. Louis Public Museum.

H. Foster Bain, Ph.D. (Chicago), geologist of the U. S. Geological Survey and formerly assistant state geologist of Iowa, has been appointed state geologist of Illinois.

DR. MELVIL DEWEY has resigned the directorship of the New York State Library and of the Home Education Department. It is expected that a statement may be made later in regard to the causes of Dr. Dewey's resignation and the future of the library school which he has conducted.

DR. HENRY M. WHELPLEY, of the medical department of Washington University, St. Louis, has been elected president of the American Conference of Pharmaceutical Faculties.

PROFESSOR S. W. WILLISTON, of the University of Chicago, lectured on 'Ancient Sea Reptiles' at Stanford University on September 19.

PROFESSOR G. H. F. NUTTALL, F.R.S., of Cambridge University, will deliver the opening address of the forthcoming winter session of the London School of Tropical Medicine on October 11.

THE fourteenth annual meeting of the Association of Military Surgeons of the United States opens in Detroit on September 26. Among the foreign representatives are Dr. S. Suzuki, surgeon-general of Japan and chief surgeon of the fleets of Admiral Togo; Drs. Ho Kan Yen, of the Chinese Navy; Ying Yung Tsui, of the Chinese Army, and Wang-Hang-Cbung, of the South China Army; and representatives from the British, Mexican, Canadian, Guatemalan and other foreign services.

DR. FRIDJOF NANSEN, who has taken a prominent part in the movement to separate Norway from Sweden, is at present in London on a special mission concerned with the status of Norway.

PROFESSOR A. G. CRAMPTON, head of the department of physics at the College of the City of New York, has returned from Spain, where he observed the eclipse of the sun.

THE expedition which Messrs. Teisserenc de Bort and Rotch sent to the tropics for the exploration of the upper air (see SCIENCE, Vol. XXII., p. 58), has returned to France on the steam-yacht *Otaria*, after a cruise of two months, during which latitude 9° N. was reached. The scientific staff, Messrs Mauricé, of Trappes, and Clayton, of Blue Hill Observatory, measured the trajectories of thirteen balloons, ascended two volcanic peaks and obtained further observations of temperature, humidity and wind from twenty kite-flights. There are besides similar data from six kite-flights executed by Mr. Clayton between Boston and Gibraltar. The observations showed the existence of a southerly anti-trade in the tropics, above twelve thousand feet, and of an easterly upper-current in the equatorial region.

THREE expeditions have been sent out by the University of Kansas in the last two years for the collection of vertebrate fossils. In 1904 a party in charge of Mr. H. T. Martin, assistant curator of vertebrate fossils, spent the year in Patagonia collecting from the Santa Cruz formation. During the summer of the same year another party in charge of Professor C. E. McClung, curator of the collections, worked the Cretaceous of western Kansas. A third expedition, having as its personnel Professor C. E. McClung, Mr. H. T. Martin, Mr. W. J. Baumgartner and Mr. R. G. Hoskins, has just returned from a trip to the John Day formations of central Oregon. The result of these collecting trips has been to add materially to the number of vertebrate specimens in the museum.

DR. F. H. SNOW, curator of the entomological collections of the University of Kansas, who for the last thirty years has made annual collecting trips to various parts of the United States, has conducted two expeditions into Texas and Arizona and returned with some thirty thousand specimens, many of which are new to science.

PROFESSOR CHARLES N. GOULD, of the department of geology of the University of Oklahoma, has been granted a year's leave of absence. He expects to spend the year at the University of Nebraska and at the Johns Hopkins University, taking advanced work along certain lines. During his absence the work at the University of Oklahoma will be in charge of Professor E. G. Woodruff.

To mark the centennial of the trip of Robert Fulton's first steamboat in the Hudson River, in October, 1807, the committee on plan and scope of the Fulton Centennial Commission has recommended the construction of a memorial arch in Battery Park and the establishment of a marine museum, on a basis similar to that on which the Metropolitan Museum of Art and the American Museum of Natural History were founded.

GENERAL ISAAC J. WISTAR, of Philadelphia, founder of the Wistar Institute of Anatomy and Biology of the University of Pennsylvania, formerly president of the American Philosophical Society, died on September 18, at the age of seventy-eight years.

TOBIAS-ROBERT THALÉN, professor emeritus of physics in the Royal University of Upsala, died on July 27.

THE superintendent of the United States Coast and Geodetic Survey has received a report from Mr. W. F. Wallis in charge of the Magnetic Observatory, Cheltenham, Maryland, that the recent disastrous earthquake in Italy was recorded by the seismograph at this observatory, on the night of September 7. The principal phases in seventy-fifth meridian mean civil time counting the hours continuously through twenty-four hours, from midnight to midnight are as follows:

	North-South Component.	East-West Component.
	h m s	h m s
Beginning	21 03 20	21 03 07
Second preliminary tremor	21 07 37	21 07 43
Beginning principal portion	21 27 03	21 23 23
End principal portion	21 40 32	21 42 04
End	21 52 36	21 57 55
Maximum amplitude	21 27 18	21 24 13
Multiplying ratio	10	10
Average period of waves:	s	s
Beginning	9.0	15.2
Principal portion	15.3	16.4
End	......	16.9
Period of pendulum	About 23	About 18

THE Carnegie Institution sent professors F. Elster and H. Geitel and Herr F. Harms, to Palma to make observations of the electric conditions of the atmosphere during the recent solar eclipse. *Nature* states that by means of a self-registering electrometer, the variation of atmospheric electricity was photographically recorded, and a series of points of the same curve was taken simultaneously by eye-readings. The ionization of the air was studied, and exact measurements of the intensity of the solar radiation within the short wave-lengths were carried out. The observations, like all others in Spain, suffered from the bad weather conditions. On the day of the eclipse rain fell during the morning; consequently it can not be considered as undisturbed with regard to atmospheric electricity. The measurements of the solar radiation were possible in a continuous series only from the first contact to the end of totality; the decrease of illumination, therefore, was determined in a satisfactory manner and without any gaps. On the other hand, clouds prevented any reading being taken during the increase of light after totality.

THE U. S. Geological Survey has in hand the investigation of curious phenomena known as 'blowing' or 'breathing' wells. In the course of collecting well records, the hydrologists of the survey have observed many wells that emit currents of air with more or less force, sometimes accompanied by a whistling sound which can be heard for a long distance. The best-known examples of this type of well are found throughout the state of Nebraska. Blowing wells are also known to occur in Rapides Parish in southern Louisiana. The force of the air current in one of the Louisiana wells is sufficient to keep a man's hat suspended above it. The cause of such phenomena is mainly due to changes in atmospheric pressure or to changes in temperature. During the progress of a low-barometer storm over these regions, the air is expelled from the blowing wells. With a rising barometer, the blowing becomes rapidly less until the current is finally reversed. Differences in the temperature of the surface air and the air in the soil also produce similar effects. When the interstices between the grains of sand, gravel, etc., in which the well is driven are filled with water, the phenomena of blowing is much less noticeable. The survey will welcome any in-

formation from well owners and drillers relating to these wells.

WE learn from the London *Times* that since May, 1904, correspondence has been proceeding between the Bengal government, the government of India and the Secretary of State upon the subject of the establishment of a school of mines in India, or, in lieu thereof, the making of provision for mining instruction at the Sibpur Engineering College, Calcutta, with practical instruction in the mining districts. The latter proposal was, on the advice of a representative committee of educational and mining experts, recommended by the Bengal government and has been sanctioned by the secretary of state. The course is to be for five years, including 18 months' training in the mining districts, where the students will work under the instruction of managers of mines. A professor of mining engineering is to be appointed from England at a salary of Rs.750 per mensem, rising annually by increments of Rs.50 to Rs. 1,000, which is equivalent to £800 per annum. A peripatetic mining instructor, with a native assistant, is also to be appointed, at the same salary, but without exchange compensation allowance. His work will be to give instruction to persons already engaged in mining work who desire to obtain certificates of competency. Such instruction is in all cases to be gratuitous, in view of the fact that 'owing to the extensive ignorance usually prevailing the mines are now for the most part worked upon unsystematic and wasteful lines, and that the absence of technical knowledge is a constant source of danger to the laborers.'

UNIVERSITY AND EDUCATIONAL NEWS.

BY the will of the late General Isaac J. Wistar, the Wistar Institute of Anatomy and Biology of the University of Pennsylvania, founded by him, will receive the residue of his estate, thought to amount to about $400,000.

AT the opening of Smith College it was announced that Mr. Andrew Carnegie had promised the sum of $125,000 to the college, providing that friends of the institution raise an equal amount. The money is to be used for the erection and maintenance of a new biological laboratory.

MR. ANDREW CARNEGIE has given $30,000 to Wittenberg College, Springfield, O., for a science hall, provided an additional $30,000 is raised for the upkeep of the building.

ACCORDING to the report of the city comptroller of New Haven the property of Yale University exempted from taxation is valued at more than $9,000,000, an increase of nearly $2,000,000 in the past three years. This does not include the Hill House property, recently acquired at the cost of some $500,000.

ON the occasion of the opening of Columbia University on September 27, the cornerstone of the new College Hall was laid, and the newly erected dormitories were open to inspection.

THE library given by Mr. Andrew Carnegie to Cornell College, Mount Vernon, Iowa, was dedicated on September 13. Bishop Henry Spellmeyer, of Cincinnati and Hon. Johnson Brigham, of Des Moines, state librarian of Iowa, delivered the addresses. The building cost a little more than fifty thousand dollars. It is strictly fire proof and is built in the old colonial style of architecture. The capacity is 70,000 volumes.

ON September 1, 1905, by the unanimous action of their respective boards of trustees the Medical College of Indiana was made the Medical Department of Purdue University with the title of 'Indiana Medical College School of Medicine of Purdue University.'

COOPERATION between the University of Chicago and a number of railroad officers has resulted in the establishment of a four-year course in railway education.

DR. HENRY S. DRINKER will be inaugurated as president of Lehigh University on October 12.

APPOINTMENTS at Brown University have been made as follows: J. Ansel Brooks, assistant professor of mechanics and mechanical drawing; James F. Collins, assistant professor of botany; Henry B. Drowne, instructor in civil engineering; Charles W. Brown, instructor in geology and mineralogy.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, OCTOBER 6, 1905.

CONTENTS.

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

CONTRIBUTIONS OF PHARMACOLOGY TO PHYSIOLOGY.[1]

LADIES AND GENTLEMEN: Before I enter upon the task for which I ask your kind attention, I desire to express my hearty thanks for the great honor you have extended to me in inviting me to deliver the Herter lectures. The honor I accept, not so much for myself as for the science which I represent.

Experimental pharmacology is a science with essentially theoretical aims—a part of general biology, in which there is nowhere shown a greater interest than in America. I take especial pleasure in asserting that in this land of varied successes the understanding of abstract problems and of purely theoretical work thrives and ever grows, always extending to wider circles, filled with a scientific idealism which invites the most splendid and admirable sacrifices, spiritual and material. Your famous university and, indeed, these lectures themselves owe their origin to such idealistic impulses. And this gives me the courage and the desire to talk to you of the significance and value of pharmacology.

It is, then, not necessary for me to claim your attention for the practical results or for their value to the practising physician; not, however, that I undervalue this important side of pharmacology. But may I not hope at this place to be able to attain my purpose most easily, if I beg your attention to the biological results which we owe to pharmacological investigations?

For the explanation and analysis of physiological function, apart from comparative physiology, stimulation and extirpation of certain organs or parts of organs serve as general methods. Experimental physiology employed to this end mechanical

[1] Being the first of the Herter lectures delivered at the Johns Hopkins Medical School, October 5, 1905.

and physical means almost exclusively. The scalpel and scissors, electrical, thermal and mechanical stimuli have long served its purposes. The manifold means of chemistry have scarcely been utilized. Its appliances and its study belong, indeed, to pharmacology, which is, as an American fellow-worker has tersely said, 'the experimental chemistry of protoplasm.'

The drugs, that is the chemical reagents, penetrate into the interior of the organs and reach parts which are not accessible to the scalpel and the electric current. Indeed, the differential action of poisons—that which has to do with single parts of organs or single especial groups of cells—is the important part of the pharmacological method. But we must concede that it has not attained for the most part the undoubted certainty and clearness of physiological methods, for every drug which we wish to use as an instrument of investigation must first itself be investigated, its mode of action first be recognized and determined. You all know well how difficult and equivocal such investigations are, and it is easily intelligible that, especially in the beginnings of such investigations, while there was no large array of pharmacological facts supporting one another, one scarcely ventured from these to draw far-reaching conclusions.

An interesting example of this sort is the admirable investigation of Felice Fontana on Indian arrow poison, which was carried out more than one hundred years ago. Fontana was forced to the conclusion, through ingenious experiments, which resembled the much later ones of Claude Bernard, that the arrow poison paralyzes neither muscle itself nor the whole nerve, but only the endings of the latter and that, indeed, the latter must possess a structure different from the nerves themselves, of which anatomy and physiology took no cognizance. Fontana, however, did not dare to draw the right conclusion because the proof was indeed a pharmacological and not an anatomical one. Only much later was it learned that properly conducted and correctly interpreted pharmacological experimentation possesses the same power of conviction as any other exact scientific method. And it is precisely the curara poison which has led to positive physiological discoveries. By its help Boehm and Nussbaum, through the discovery of the so-called paradoxical vagus action, discovered the vasopressor nerves and the accelerator fibers in the trunk of the vagus nerve in dogs and cats; and later, with the help of the same poison, Boehm obtained the proof, otherwise inaccessible to physiology, that the nerve endings in the muscles possess the same capacity for fatigue and recovery as the muscle itself. The important problem of the close connection between the irritability and the conductivity of nerves was not soluble except by the aid of the pharmacological method, that is, the methodical utilization of poisons like curara, veratrin and carbon dioxide.

Formerly it was impossible to detect any physiological or morphological difference either in the arrangement or in the general structure of centrifugal and centripetal nerve tracts. But the narcosis experiments of Fraser, Alms, Joteyko and especially the more recent ones by Dixon with cocain, showed that they must be chemically different from one another, inasmuch as they react differently to poisons.

Highly important, also, are the physiological results which Langley obtained with the help of nicotin poisoning in relation to the sympathetic ganglia. He was able to show that by means of nicotin the sympathetic ganglia, and through them all the preganglionic nerves, were paralyzed, while the post-ganglionic nerves escaped. So it is possible to decide by this means

whether a nerve ends in a sympathetic ganglion or passes through it, as is the case, for example, with the trigeminus fibers through the ciliary ganglion.

The study of the action of a wholly different type of poison, namely tetanus toxin, has also furnished a series of important facts relating to the field of neurophysiology. If one injects into an extremity of a warm-blooded animal a sterile toxin derived from tetanus bacilli, there occurs, as is well known, a local tetanus, that is to say, the inoculated limb enters into tonic extension and shows, especially in the later stages of the poisoning, an increased reflex irritability, while all the remaining parts of the body continue to retain their normal position and normal reflex excitability. Now, it was possible to show that this remarkable phenomenon arose through the circumstance that the poison was absorbed by the adjacent motor nerve-ends and carried upward in the axis cylinder to corresponding centers of the spinal cord. The blood and lymph channels are wholly unconcerned in this transportation of the poison, and there consequently remains only the possibility that there is constantly flowing through the axis cylinder of the motor nerves a centripetal protoplasmic stream, reaching as far as the ganglia of the neurones. This was a previously unknown fact which must be of significance for the nutrition of the nerves and also for the trophic disturbances of the central ganglia which develop after section of the peripheral nerves. I have also found that such a centripetal flow of diphtheria toxin occurs in the nerves and the same thing seems to be true of certain metals which, like lead, give rise to chronic neuritic palsies. Perhaps a stream of this kind passes also along the sensory nerves, but in any case its course is arrested by the spinal ganglia, so that the tetanus poison is here held fast and is unable to reach the sensory apparatus of the spinal cord. If, on the other hand, one injects the posterior nerve-roots between the root ganglion and cord, there occurs an irritation of the sensory pain-exciting apparatus in the spinal cord and, indeed, without simultaneous irritation of motor or reflex structures. There thus arises the pure so-called tetanus dolorosus, which is characterized by the periodical recurrence of extremely painful seizures, excited apparently through the summation of minimal and, ordinarily, wholly inactive stimuli. It makes no difference, as regards the development of the phenomenon, whether the spinal ganglion has or has not been removed—a fact which was shown by Fletcher. In this manner has arisen the proof of the existence of wholly special pain-subserving structures in the central mechanism of the spinal cord (the existence of which was long denied by French physiologists)—structures distinct from those subserving tactile and motor functions.

Finally these investigations have brought to light another remarkable fact. In the ordinary poisoning through tetanus toxin the muscles are the seat of two distinctly different kinds of phenomena. In the first place, the involved muscles become shortened without undergoing contraction in the physiological sense. This condition may exist alone. In the resting state they show neither the electrical phenomena nor the heat production nor the muscle tone that characterizes a state of activity. They shorten only slowly and the affected extremity thus becomes stiff and gradually immobilized. If the muscles have not undergone maximal shortening, they are still capable of voluntary or reflex contraction, as in the case of normal muscles. It is only later that we see the well-known strychnine-like reflex tetanus in which the muscles are implicated in rapidly recurring, increasingly accentuated contractions. Since it is

possible to show that both the phenomena are subserved wholly by the spinal cord, it follows that there are present in the spinal cord various structures, quite distinct from the ordinary motor mechanism, which determine the state of inactive tension of the muscles, that is to say, their length while in a state of rest. These tonus-subserving structures are not excited by other poisons, like strychnine, and we have here the fundamental distinction between strychnine poisoning and poisoning by tetanus toxin. Indeed, it was only by means of the latter poison that the existence of these length-regulating tonus centers in the spinal cord was brought to light.

I have spoken hitherto of the nervous system itself, but it is true that the physiology of structures closely connected with the nervous system, as the glands, heart, blood vessels and muscles, has been materially advanced through the use made of pharmacological agents. You are all aware of the progress in our knowledge of lymph formation and the glandular function, which we owe to studies of Heidenhain; and these again were dependent in a great degree upon the help of pharmacological methods involving the application of specific chemical stimuli. I shall mention the results of some more recent investigations in this same direction, in the belief that they may be less familiar to you. Very recently Wertheimer and Lepage, in Lille, reported a series of pharmacological investigations on secretion by the pancreas, which led them to important results. It has long been known that the pancreas may be stimulated to secretion in a reflex manner and also, as Pawlow showed, through direct irritation of the vagus nerve. We know also, as a result of Starling's work, that the pancreas can be thrown into activity directly through the specific chemical stimulus furnished by the presence of secretion in the circulating blood. Now, Wertheimer and Lepage were able to show that the gland has at least two distinct mechanisms through which it is possible to excite the secretion of pancreatic fluids; first, certain structures intimately connected with the vagus nerve, which may be excited by pilocarpine, physostigmine or muscarine, or completely paralyzed by atropine; and secondly, another set of structures which are not acted upon by these poisons, being neither excited nor paralyzed by them, but which react to certain other definite chemical stimuli like secretin. Possibly the latter apparatus is part of the sympathetic nervous system; at all events the case of the submaxillary gland has been brought forward by Wertheimer and Lepage as analogous, since in this case the terminations of the chorda may be influenced by pilocarpine and atropine, whereas the sympathetic nervous mechanism remains intact. And, finally, just as the salivary secretion differs according as it arises through the stimulation of the chorda or of the sympathetic nervous system, so does the pancreatic secretion resulting from the pilocarpine differ from that which is obtained through the action of secretin. In the latter case the secretion contains entero-kinase, that is to say, is able to digest albumin without the addition of succus entericus.

In this connection it may be mentioned that the use of pilocarpine has led to a physiological understanding of an entirely different kind of secretion, namely, the liberation of a gas. It has long been known that the swimming bladder of fishes contains a gas, the presence of which can hardly be explained by a process of simple diffusion out of the tissues. This fact, which we owe to the observation of Huefner, led Dreser to investigate the process of liberation of oxygen into the swimming bladder of the pike, with a view to determining whether pilocarpine and other

glandular stimulants gave rise to an increased accumulation. And, indeed, he found that when fishes were repeatedly injected with pilocarpine, the content of the swimming bladder in oxygen gas was distinctly greater than in the case of the gas from the normal fishes, which permits the conclusion that the epithelia of the swimming bladder liberate a gas in a manner analogous to the liberation of secretions from true glands, and further that these epithelia are not penetrable in either direction like a diffusing membrane.

Another fact deserves brief notice in this relation. It is the interesting observation of Magnus that when ammonia gas is injected into the veins the alveolar epithelium of the lungs is not penetrable, since no trace of ammonia can be detected in the expired air, whereas after the inhalation of ammonia the gas penetrates readily into the blood through these same epithelial cells. This is merely one striking example of the many known cases in which animal epithelial membranes are penetrable in one direction for certain substances like water, salts or urea, while opposing strong resistance to the passage of these in the opposite direction. The mechanism of this regulatory arrangement has not yet been cleared up and further progress seems hardly possible without the aid of pharmacological methods.

To enter upon the physiology of the heart at this time would carry us too far. Pharmacological facts which have proved of importance in giving us our present knowledge are doubtless sufficiently known to you. We may say, however, that even in regard to the recent controversy over the myogenic and neurogenic theories of the cardiac motions and over the general character of the heart muscle, the systematic study of the cardiac poisons has contributed much that is important and, as Harnack has indicated, may perhaps furnish the final decision.

Permit me now to direct your attention, for a few moments, to some of the physiologico-chemical results of pharmacological investigations. It lies in the nature of things that the results should be numerous in a field that has to do solely with the chemical inter-relations between the pharmacological agent and the living organism. I shall not tire you with an enumeration of facts already well known. I shall refer only to a few of the more significant biological reactions which we owe to pharmacological investigation. The study of poisoning by acids led to the discovery of ammonia-production in the organism, and this in turn to the Schroeder experiments, which positively demonstrated the production of urea in the liver. Pharmacological methods have also contributed materially to the elucidation of numerous other important problems in metabolism. One of the most actively discussed problems has been the question whether sugar can arise from proteid, and this question has been definitely answered, as it seems to me, by the experiments of Rolly. This observer conducted experiments on animals which had been rendered glycogen-free by means of fasting and strychnine spasms. He then brought about an increased destruction of proteids by means of fever, induced through the action of bacteria and toxines and was able to demonstrate that there occurred a new production of glycogen under these circumstances in the liver and in the muscles. As the fat-reserve of the animals had already sunk to a minimum during the period of fasting, it is clear that the source of the newly formed glycogen is to be sought in the increased destruction of proteids in the organism. The same sequence of events was demonstrated by Rolly in fasting rabbits at the time of the

great destruction of proteids that immediately precedes death.

That the problem of diabetes mellitus, though still unsolved, has received light from many sides through pharmacological investigations, I need hardly state. I will merely remind you that the discovery of phlorhizin diabetes showed us a hitherto unknown capacity of the kidney to secrete sugar, that the work of Lusk and his associates led to the establishment of a definite ratio between nitrogen and dextrose excretion in diabetes, and that Blum and Herter found an adrenalin glycosuria which may perhaps throw some light on the puzzling nervous forms of diabetes.

Again, through poisoning by phosphorus and arsenic the relation of lactic and the amido-acids to the intermediary metabolism was first shown, while as regards the more intimate metabolic processes and their relation to ferment action, the toxicological experiments of Jacobi and of Wakeman have brought us important light. Through poisoning by chloral, by camphor and nitrotoluol, the discovery of glycuronic acid was made, the normal occurrence of which in the organism was only later established. Indeed, the various chemical reactions of the organism, of which we have examples in the formation of hippuric acid in the kidneys, in sulphocyanide, in methylation, in oxidation and reduction, were all of them first discovered through the action of chemical or pharmacological agents. Furthermore, as regards the location and intensity of these processes, the investigations of Ehrlich and of Herter have given us definite information. I would like to refer here to an interesting observation from Herter's studies which demonstrates with special clearness to the eye the oxygen requirements of the muscles and shows with what energy the muscles appropriate oxygen not only from oxyhemoglobin, but also from other reducible substances. Herter found that if animals receive intravenous infusions of methylene blue the pectoral muscles were soon colored deep blue, but that if during the experiment the access of oxygen was hindered by giving the animals air mixed with carbon monoxid, the blue muscles in a few seconds recovered their natural red color; they had almost momentarily reduced the methylene blue to the colorless leucobase. It is also known that through the action of hydrocyanic acid the capacity of the organs to take up oxygen from the blood is much reduced or destroyed. This process also it was possible to render easily visible by the method of methylene blue infusion. As we have seen, the pharmacological method has revealed to us a series of functional characters of the organism; but its biological significance appears to extend even further. It seems possible with such methods, if only gradually, to reach a more intimate knowledge of the chemical constitution of protoplasm, and finally, perhaps, to arrive at an insight into the chemical interpretation of its functions. If, under the influence of a pharmacological agent, we observe an immediate essential alteration in the function of a cell, we have to assume that a chemical change has occurred in its vital center—in what Ehrlich has called the 'Leistungskern,' that is, the chemical center of vital activity. On the other hand, if we have before us a gradually developing alteration, this may have been called forth in a secondary manner, through chemical changes in the reserve material or in the supporting elements of the cells, perhaps in the groups of atoms which we conceive as side-chains. Given a knowledge of the constitution and the chemical mode of action of agents operating as acute intoxicants, we should also be able to reach conclusions as to the chemistry of their point of attack, that is to say, regarding that substratum of the living sub-

stance which corresponds to the chemical constitution and action of the poison. With a similar idea in mind Oscar Loew, twenty years ago, considered himself justified in assuming the presence of an aldehyde group in the living protoplasm, basing this view on a series of merely qualitative toxic reactions like those obtainable by hydroxylamine, diamid and other substances.

An example of another pharmacological method which may, perhaps, prove of utility is the investigation of the narcotics. The quantitative comparison of the action of aliphatic narcotics (alcohol, ether, chloroform, etc.) leads to what I believe to be the unavoidable conclusion that certain fat-like substances like lecithin must be conceived as constituting integral parts of the 'Leistungskern.' It happens that one can compare with considerable exactitude in a quantitative way, the efficacy of this numerous group of bodies. This comparison has brought out the fact that the degree of activity is approximately proportional to the individual chemico-physical affinities of all these substances, that is their solution-tensions for fat-like bodies compared with their solution-tensions for watery media. From this almost rigid parallelism it follows with a high degree of probability that in the union of ether, chloroform, etc., to a fat-like substance—a lipoid—we have the origin of the narcosis of the cell; in other words, the lipoid belongs to the essential functionally active constituents of the cell. It has been urged against this conclusion that the cell lipoids occasion merely a stronger or a weaker accumulation of the narcotic which then acts on the true albuminoid life-center of the cell in proportion to the degree of this accumulation. There are, in reality, only two possibilities. First, one may assume that the narcotic operates only through its presence in lifeless lipoids whence it acts from a distance, perhaps through a sort of induction, upon the living cell-center itself, without entering into reciprocal chemical action with its center. Such a view could be neither refuted nor established. But in order to explain the above-mentioned parallelism, it would be necessary, on this supposition, to invoke the aid of the very improbable hypothesis that all the different narcotic substances, compared on an equimolecular basis, exert an equally strong induction. And this hypothesis wholly fails to allow for the different influence of special groups of atoms, as, for example, the ethyl group, the methyl group, etc. Hence it is clear that such an action at a distance must remain problematical, and furnishes us no actual explanation. On the other hand, we may make the much more likely assumption that the narcotic substance enters into a reciprocal, reversible, chemico-physical action with some constituent of the 'Leistungskern' or 'life-center,' the strength of which reaction is dependent on the intensity of this reciprocal action. Then again, the law of mass action here comes into play, that is the law of distribution. We may even leave the lipoid for the moment out of account. In this case it would have to be regarded simply as an intermediary solvent and would remain without influence upon the equilibrium established by the narcotic between the blood and lymph plasma on the one hand and the 'Leistungskern' or 'life-center' on the other. Experiment, however, showed that the affinity of the living cell substance for a narcotic, measured by the observed intensity of action, runs parallel to the experimentally observed fat affinity of the narcotic, or, in other words, that the unknown constituent of the living cell or 'Leistungskern' must itself possess certain properties of a fatty substance, or, in short, must itself be a fat-like or lipoid body. And thus we come back to the very conclusion of which I have already spoken. I have expressed

myself in somewhat greater detail than is perhaps warranted by the importance of the question. I have, however, thought such a critical discussion of the problem of some interest, as it seems of fundamental significance for the evaluation of a pharmacological analysis of this kind.

I have already said that perhaps the highest result of pharmacological investigation may prove to be the winning of an insight into the chemical nature of life processes themselves; indeed, the first important ground in this direction has already been won. You are all familiar with the important investigations of Jacques Loeb, to whom we owe a knowledge of the essential significance of the individual metallic ions, for the general life processes. But what is still more important, Loeb has succeeded in inducing very special biological reactions as the effect of chemical action. He has shown that heliotropism can be excited by definite chemical reagents such as carbon dioxide and other substances, instead of through the action of light, which is a contribution to the understanding of the mechanism of this singular reflex function. Finally, he has shown that through certain definite chemical procedures, like the action of hypertonic salt solutions, combined with ethyl acetate, the unfructified eggs of sea-urchins may be stimulated to parthenogenetic normal development, an observation which may prove of great significance for the understanding of the process of fertilization.

And with the mention of this admirable investigation, permit me to close my address of to-day.

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THE GEOGRAPHICAL DISTRIBUTION OF THE STUDENT BODY AT A NUMBER OF AMERICAN UNIVERSITIES

THE accompanying table explains the geographical distribution of the student body of six of the leading universities of the east and of three western institutions for the academic year 1904–1905, summer session students being omitted in every instance. In the case of Harvard University the students of Radcliffe College (undergraduate women) are not included. Efforts were made to include three other prominent western universities, but it was impossible to secure the necessary figures in shape for comparison. Examining the figures by divisions, we note in the first place that the student clientele of the University of Michigan is by no means confined to the central states, for almost four hundred students at this institution hail from the North Atlantic division. The student bodies of the other western universities included in the table, Illinois and Indiana, are to all intents and purposes local in character, although the former draws some students from the south and west. Harvard has the greatest hold on the New England states, leading in all of them except Connecticut, in which state Yale naturally occupies first place. Columbia has more students from the entire North Atlantic division than any of the other institutions, leading in its own state, and strange to say, drawing more students from the state of New Jersey than Princeton does. The University of Pennsylvania, as we should expect, has the largest following in its own state, Princeton ranking second and Cornell third.

The most striking fact to be noted in the South Atlantic division is the hold that Cornell has on this section of the country. The University of Pennsylvania, chiefly by reason of its proximity to several states in this division—notably Delaware and Maryland—draws the next largest number of students, with Columbia third and Harvard fourth, all of the universities mentioned having over one hundred students from this division. Cornell leads in the District of Columbia, with Harvard a close second.

RESIDENCES OF STUDENTS. A.—THE UNITED STATES

1904-1905	Columbia	Cornell	Harvard	Illinois	Indiana	Michigan	Pennsylvania	Princeton	Yale
North Atlantic Division	**3554**	**2405**	**3235**	**86**	**6**	**394**	**2372**	**143**	**2121**
Connecticut	84	55	59	1		7	38	17	1009
Maine	20	10	120	1		8	11	4	23
Massachusetts	61	63	2126	3		17	45	23	166
New Hampshire	4	11	68	1		3	12	3	9
New Jersey	435	142	67			11	193	296	102
New York	2809	1808	512	20	2	195	122	252	580
Pennsylvania	109	296	175	8	4	140	1939	342	194
Rhode Island	13	12	84	1		2	6	2	24
Vermont	19	8	24	1		11	6	4	14
South Atlantic Division	**118**	**175**	**114**	**8**	**1**	**38**	**147**	**87**	**99**
Delaware	6	5	3				33	2	7
District of Columbia	5	49	40	2		13	23	17	25
Florida	12	3	4			4	8	3	6
Georgia	22	6	6	1		9	6	4	11
Maryland	16	52	24	2		1	39	43	14
North Carolina	20	16	7	1		1	7	3	9
South Carolina	13	8	12	2		1	4	4	12
Virginia	17	26	10			4	16	7	8
West Virginia	7	10	8		1	5	11	4	7
South Central Division	**72**	**76**	**88**	**47**	**14**	**64**	**44**	**72**	**80**
Alabama	13	15	10	1		1	11	5	9
Arkansas	8	5	7	4		5	2	1	2
Indian Territory				3		2			1
Kentucky	18	10	33	9	9	26	20	28	24
Louisiana	7	8	9	6		1	1	1	9
Mississippi	9	10	3	5	1	1	1	7	3
Oklahoma			4	3		9	1	1	1
Tennessee	5	6	11	2	4	8	1	13	19
Texas	12	22	11	14		11	7	16	12
North Central Division	**262**	**381**	**526**	**3164**	**1504**	**3155**	**139**	**209**	**506**
Illinois	25	112	115	2683	15	285	23	58	140
Indiana	31	30	38	84	1453	144	18	22	36
Iowa	18	23	47	101	4	84	9	21	32
Kansas	12	2	15	18		27	5	3	21
Michigan	24	24	29	45	1	2199	9	6	35
Minnesota	23	14	23	24	6	19	4	10	40
Missouri	25	25	44	42		43	7	29	51
Nebraska	11	8	13	11	1	14	2	3	8
North Dakota	2	3	6	6		11	1		2
Ohio	73	125	160	35	23	285	52	46	119
South Dakota	4	3	2	15		8	3	1	3
Wisconsin	14	12	34	100	1	36	6	10	19
Western Division	**111**	**76**	**126**	**41**	**2**	**134**	**22**	**41**	**78**
Arizona	3		1	1		1			
California	31	15	52	11	1	23	5	6	21
Colorado	28	22	24	7		28	4	15	26
Idaho	4	2	3	5		10			1
Montana	13	5	7	7		25		4	3
Nevada	1					1			
New Mexico	1		2	2		6			
Oregon	9	6	12	1		7	2	5	10
Utah	15	13	10	3	1	14	2	7	7
Washington	6	11	12	4		15	9	3	8
Wyoming		2	3			4		1	2
Insular and Non-Contiguous Territories	**4**	**17**	**9**	**4**	**4**	**9**	**3**	**2**	**15**
Alaska								1	
Hawaiian Islands	2	5	6	1		1			10
Philippine Islands		9	2	2	4	3	1		5
Puerto Rico	2	3	1	1		5	2	1	
Total	**4121**	**3130**	**4098**	**3300**	**1531**	**3794**	**2727**	**1354**	**2899**

RESIDENCES OF STUDENTS.—*Continued.* B.—FOREIGN COUNTRIES

1904-1905	Columbia	Cornell	Harvard	Illinois	Indiana	Michigan	Pennsylvania	Princeton	Yale
North America	**51**	**38**	**43**	**9**		**23**	**41**	**8**	**31**
Canada	30	21	34	5		14	21	6	30
Central America	3	2					6		
Cuba	8	8	3			1	5	1	1
Mexico	8	7	3	4		8	3	1	
West Indies	2		3				6		
South America	**4**	**18**	**1**			**2**	**11**	**1**	**2**
Argentine Republic		9				1			1
Brazil	1	5	1				4		1
Chili	2						5		
Colombia						1		1	
Ecuador		1							
Paraguay							1		
Peru	1	3					1		
Europe	**26**	**21**	**25**	**3**	**1**	**5**	**28**	**5**	**11**
Austro-Hungary	1	1					2		
Belgium							1		
Bulgaria		1	1			1			
France	1	1	5				3		2
Germany	4	1	3			1	5		
Greece									1
Great Britain and Ireland	10	6	9			1	4	4	2
Holland	1	2	1			1	1	1	
Italy	3		1				1		
Norway		1		2					
Portugal				1					
Roumania		1							
Russia	3	2					5		
Spain	2		1				1		
Sweden	1	2					1		
Switzerland							4		
Turkey		3	4		1	1			6
Asia	**29**	**14**	**15**	**4**	**6**	**8**	**9**	**6**	**34**
Asia Minor	2						1		8
China	6	6	1					1	6
India	2	2	1		1	2	1		1
Japan	19	6	13	3	5	6	7	5	19
Persia				1					
Africa	**4**	**2**	**2**				**1**		**2**
Cape of Good Hope	2								1
Mauritius									1
Morocco			1						
Natal	1								
Transvaal	1	2	1				1		
Australasia	**3**	**7**	**8**	**2**			**36**		**3**
Australia	3	6	5	1			23		2
New Zealand		1	3	1			13		1
Total	**117**	**100**	**94**	**18**	**7**	**38**	**126**	**20**	**83**
Grand Tota	**4238**	**3230**	**4192**	**3318**	**1538**	**3832**	**2853**	**1374**	**2982**

Columbia has the largest following in the states of Florida, Georgia, North Carolina and South Carolina, many of these students being registered in the graduate faculties and in Teachers College. Cornell leads in Maryland and Virginia, with Princeton second in the former state and Columbia in the latter. Illinois and Indiana have no representation to speak of in this section of the country.

In the south central division Harvard leads with 88, Yale is second with 80, and Cornell third with 76, Columbia and Princeton following close behind with 72 each. Cornell leads in Alabama and Mississippi, with Columbia second in each. In

Arkansas Columbia leads, with Harvard second; Harvard and Yale have the largest number from Louisiana; Harvard leads in Kentucky, Yale in Tennessee and Cornell in Texas, with Princeton second in each. The largest Oklahoma delegation is found at Michigan. The large number of students from the state of Kentucky is worthy of mention.

The universities of the middle west are naturally far in the lead in the north central division, Illinois ranking first, although Michigan is not far behind. Of the eastern universities Harvard stands first in this division, with Yale second, Cornell third and Columbia fourth. The University of Indiana has few followers outside of its own state, whereas the Universities of Illinois and Michigan are well represented in all of the states of the division. Of the eastern universities Yale leads in Illinois, with Harvard second, Cornell also having over one hundred students from this state, many of whom hail from the city of Chicago, which, like the city of Washington, is a Cornell stronghold. In Indiana and Iowa Harvard leads the eastern universities, with Yale second, Columbia being third in the former and Cornell in the latter state. In Kansas, Michigan, Minnesota and Missouri Yale leads Harvard, Columbia being third in Kansas, tying with Cornell for third place in Michigan and Missouri, and with Harvard for second place in Minnesota. Harvard has the largest following of the eastern universities in Nebraska, North Dakota, Ohio and Wisconsin, Columbia leading in South Dakota. All of the eastern universities attract more students from Ohio than Illinois or Indiana, although Michigan has by far the largest student body from that state, Harvard, Cornell and Yale also being well represented.

In the western division Michigan leads, with Harvard second and Columbia third, all of these institutions drawing over one hundred students from this section, many of whom are enrolled in the scientific schools, at least as far as Michigan and Columbia are concerned. Columbia leads in Arizona, Colorado (with Michigan) and Utah, Harvard in California and Oregon, Michigan in Idaho, Montana, New Mexico, Washington and Wyoming. California and Colorado send by far the largest delegations to the universities included in the table, the representation of Arizona, New Mexico, Nevada and Wyoming at the eastern universities being insignificant.

The insular territories are just beginning to send students to the American universities and their representation will no doubt increase rapidly in the immediate future. Cornell leads all the other universities enumerated in the number of students from these territories. There is only one student from Alaska at any of the institutions in the list, namely, at Princeton. Yale leads in the Hawaiian Islands, Cornell in the Philippine Islands, and Michigan in Puerto Rico.

As for the representation from foreign countries, the University of Pennsylvania is in the lead, with Columbia second and Cornell third, the great majority of Pennsylvania's foreign students being registered in the dental school of that institution. It is worthy of note that there are over six hundred students from foreign countries enrolled at the nine universities included in the table, which is, indeed, a remarkable showing, and it is safe to predict that this number will show a constant increase in the coming years. No less than 125 of these foreign students hail from Europe. In North America Columbia leads, with Harvard second and Pennsylvania third; Cornell has the largest following in South America, with Pennsylvania second and Columbia third; in Europe Pennsylvania leads, with Columbia second and Harvard

third; Yale leads in Asia, with Columbia and Harvard following in the order named; Columbia leads in Africa and Pennsylvania in Australasia. Of the European countries Great Britain furnishes the largest delegation, while the largest number of Asiatic students hail from Japan.

Much has been said and written lately about the decrease in the number of western students in attendance at eastern institutions, but the accompanying figures show that all of the eastern universities enumerated still have a considerable following in the west and south. It is a following that is, in most cases, actually increasing each year, although, of course, not at the same rapid rate at which most of the western universities are growing in number of students. The accuracy of the figures is somewhat marred by the fact that a tendency exists on the part of students who are not residents of the place in which their university is located, to register this place as their permanent residence. This tendency is encountered especially at institutions located in large cities, but the general results are not affected thereby.

The table illustrates in striking manner the truly national character of the leading eastern universities and of several of the western institutions, and it is to be hoped that they will retain this characteristic in the coming years, since it is undeniably an important factor in the ever spreading unification of the various sections of the country. RUDOLF TOMBO, JR.

COLUMBIA UNIVERSITY.

SCIENTIFIC BOOKS.

Traité de Biologie. Par FÉLIX LE DANTEC, chargé du cours d'Embryologie générale à la Sorbonne. Paris, Alcan. 1903. Pp. 553.

This book, which is the condensation and completion of the numerous studies in biological theory (and in several other subjects) that have come from the productive pen of M. Le Dantec during the past ten years, is one of the most ambitious and elaborate of the recent attempts to synthetize the general results of biological research. As such, it will be of interest to both the philosopher and the naturalist. M. Le Dantec covers the whole ground and something more, adding a lengthy appendix in which the 'biological foundations' of psychology and sociology are set forth. The psychological chapter is chiefly remarkable for the author's entire innocence of any suspicion that mental phenomena have any peculiarities or complexities of their own. Thus, consciousness is once for all disposed of by this definition: 'Consciousness is the property which our body has of being informed at each moment of its structure at that moment' (*la propriété d'être au courant de sa structure actuelle*); the obvious objection that this definition takes no account of the facts that we know very little of our structure and that consciousness chiefly is representative of 'objects,' is summarily met, *en passant*, by observing that 'this property suffices to bring it about that we are secondarily aware of what goes on about us, as a result of the effect upon our structure of those external events that make an impression upon our sense-organs.' Here all that requires explanation, and correlation with physiological phenomena, is cheerfully taken for granted at the start. This 'property' which is consciousness, moreover, is not confined to our bodies, but—though never aught but an epiphenomenon, functionless in evolution—extends down to the simplest material structure; the argument to which the grounds for the mind-stuff theory reduce themselves, for M. Le Dantec, may be commended to the logician as a classic example of the fallacy of division: "Since our consciousness is so intimately connected with our structure, and since we are formed of chemical substances—carbon, hydrogen, *etc.*—we ought to conclude that these chemical substances contain in themselves the elements of our consciousness, and that, just as our body is built up of atoms, our consciousness is built up out of the elements of consciousness connected with each atom." It is really depressing to find men learned in one science still reasoning like babes and sucklings in another —and convinced, withal, that they alone know

anything about the matter. The sociological chapter is inconclusive; nothing very specific seems to be built upon the 'biological foundations,' in this case, except the doctrine—which one had supposed extinct these many years—that we should bring up our children by 'teaching them exclusively truths that are beyond dispute, such as those of mathematics, geography, anatomy.'

When, however, he sticks to his last, M. Le Dantec has much that is not only significant, but also closely reasoned, to say, and the book can not be neglected by any who are interested in the larger problems of general biology. The work is characterized by an unusually careful attention to the question of biological method—to the determination of the nature and limits of 'explanation' in this science—and should be of use in increasing, so to say, the methodological self-consciousness of naturalists. No one, doubtless, was ever more resolute than M. Le Dantec to banish confusion and equivocation from biological language, to define at the outset the peculiar 'biologist's fallacies' and, above all, to avoid the naturalist's besetting temptation, the use—especially in dealing with such processes as cell-division and maturation—of vaguely teleological phraseology. As the chief sinner in this and other matters of method, Weismann is pursued throughout the book with somewhat excessive ferocity; 'the meeting-place of all the errors possible in biology,' is one of the characterizations of Weismann's system. The main purpose of the book, however, is 'to describe the known part of the phenomena of life in physico-chemical terms,' and to 'show that life is no more essentially different from other natural phenomena than are the properties of benzine essentially different from those of alcohol.' This, however, does not mean that the author proposes to bring vital phenomena under the already known laws of chemistry or physics. He regards the power of assimilation as the primary and only essential characteristic of living matter; and assimilation, though a chemical reaction, is, upon the author's own showing, an entirely unique and even somewhat paradoxical chemical reaction. Beginning with a proposed formulation of the nature of this primary process, M. Le Dantec attempts to correlate with this in a connected manner—and in that sense, to explain—the laws of the other vital phenomena, offering, by the way, many observations that are of value apart from their connection with the main argument. The book, which is copiously illustrated with good diagrams, makes abundant use of recent biological investigations, and is full of ingenious hypotheses that are illuminating and suggestive, even where the reader feels that the author has not constantly discriminated between 'possible hypothesis' and 'only possible hypothesis.' To go into full details of the discussion lies neither within the competency of the present reviewer nor within the limits of reasonable length.

ARTHUR O. LOVEJOY.

SCIENTIFIC JOURNALS AND ARTICLES.

THE first article in the August number of the *American Geologist* is a biographical sketch with portrait of Professor Albert A. Wright by Professor George F. Wright. Professor W. O. Crosby contributes the second installment of his article on the 'Genetic and Structural Relations of the Igneous Rocks of the Lower Neponset Valley, Massachusetts.' The longest paper and the one of greatest general geological interest is by Drs. J. W. Beede and E. H. Sellards on the 'Stratigraphy of the Eastern Outcrop of the Kansas Permian.' The writers accept the Wreford limestone as the base of the Kansas Permian and they have traced and mapped this limestone from southern Nebraska nearly across Kansas. Its outcrop is shown on a map, while another plate gives a characteristic view of the 'Flint Hills Escarpment' in Kansas, which is composed in part of lower Permian formations. In conclusion the writers state 'that the strata of the lower Permian are remarkably persistent and uniform when the great extent of outcrop is considered.' President Charles R. Keyes contributes a paper on 'The Fundamental Complex beyond the Southern End of the Rocky Mountains.'

The October number of *The American Journal of Science* contains the following articles:

B. B. Boltwood: 'Ultimate Disintegration Products of the Radioactive Elements.'

C. P. Flora: 'Use of the Rotating Cathode for the Estimation of Cadmium taken as the Sulphate.'

A. J. Moses: 'Crystallization of Luzonite and other Crystallographic Studies.'

F. E. Wright: 'Determining of the Optical Character of Birefracting Minerals.'

C. Barus: 'Groups of Efficient Nuclei in Dust-Free Air.'

T. Holm: 'Studies in the Cyperaceæ.'

P. F. Schneider: 'Preliminary Note on Some Overthrust Faults in Central New York.'

F. N. Guild: 'Petrography of the Tucson Mountains, Pima Co., Arizona.'

The American Chemical Journal for October contains articles, as follows:

C. Loring Jackson and Latham Clarke: 'Bromine Addition-Compounds of Dimethylaniline' (Contributions from the Chemical Laboratory of Harvard College).

Harry C. Jones and H. P. Bassett: 'The Approximate Composition of the Hydrates Formed by a Number of Electrolytes in Aqueous Solutions, Together with a Brief General Discussion of the Results Thus Far Obtained.'

SOCIETIES AND ACADEMIES.

AMERICAN MATHEMATICAL SOCIETY.

The twelfth summer meeting of the American Mathematical Society was held at Williams College, Williamstown, Mass., on Thursday and Friday, September 7–8. Twenty-eight members were in attendance. Two sessions were held on Thursday, and a third on Friday morning. Professors Morley and Ferry filled the chair. The council announced the election of the following persons to membership in the society: Lieutenant-Colonel C. P. Echols, U. S. Military Academy; Professor G. B. Guccia, University of Palermo; Professor H. B. Evans, University of Pennsylvania; Dr. A. M. Hiltebeitel, Princeton University; Dr. J. M. Poor, Dartmouth College; Professor J. E. Williams, Virginia Polytechnic Institute. Eight applications for membership were received. The total membership of the society is now nearly five hundred.

At the close of the Thursday morning session the members were conducted through the grounds and buildings of Williams College and the collection of mathematical models were shown. On Friday afternoon the members assembled at the house of President Hopkins and through the courtesy of the college were taken in carriages on an excursion over the Berlin Mountain, whose less accessible regions were traversed on foot. Several foot tours were also made on Saturday. The hospitality of the college authorities was appropriately recognized by appreciative resolutions at the close of the meeting.

The following papers were read at the meeting:

W. H. Bussey: 'Galois field tables for $p^n \leqq 169$.'

Edward Kasner: 'A geometric property of the trajectories of dynamics.'

G. A. Bliss: 'A generalization of the notion of angle.'

W. B. Fite: 'Irreducible linear homogeneous groups.'

Saul Epsteen: 'Note on the structure of hypercomplex number systems.'

Maurice Fréchet: 'Sur l'écart de deux courbes et sur les courbes limit.'

Richard Morris: 'On the expressibility of the automorphic functions of the group $(0, 3, l_1, l_2, l_3)$ in terms of theta series.'

J. I. Hutchinson: 'On certain hyperabelian functions which are expressible by theta series.'

N. J. Lennes: 'Concerning real functions of one real variable which are completely determined over an interval by the values of the function and its derivatives for one value of the independent variable.'

W. A. Manning: 'On the arithmetic nature of the coefficients in groups of finite monomial linear substitutions.'

Max Mason: 'On the boundary value problems of linear ordinary differential equations of the second order.'

G. A. Miller: 'On the possible number of operators of order 2 in a group of order 2^n.'

Frank Morley: 'On two cubic curves in triangular relation.'

C. H. Sisam: 'On the determination of the nodal curve on a ruled surface.'

A. S. Chessin: 'On the strains and stresses in a rapidly revolving circular disc.'

L. E. DICKSON: 'On the quaternary linear homogeneous groups modulo *p* of order a multiple of *p*.'

L. E. DICKSON: 'On finite algebras.'

VIRGIL SNYDER: 'On a type of rational twisted curves.'

E. J. TOWNSEND: 'Arzelà's condition for the continuity of a function defined by a series of continuous functions.'

H. S. WHITE: 'Rational plane curves as related to Riemann transformations.'

F. R. MOULTON: 'A class of periodic solutions of the problem of three bodies.'

C. N. HASKINS: 'Note on the differential invariants of a surface and of space.'

E. V. HUNTINGTON: 'The continuum as a type or order: an exposition of the modern theory.'

The next meeting of the society will be held at Columbia University, on Saturday, October 29. The San Francisco section meets at the University of California, on September 30. The annual meeting of the society for the election of officers will be held on Thursday and Friday, December 28–29.

F. N. COLE,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE PROBABLE ORIGIN OF CERTAIN BIRDS.

IN a recent article in SCIENCE,[1] Mr. W. E. D. Scott attempts to apply the 'mutation' theory of de Vries to the origin of certain puzzling forms of North American birds, his conclusion being:

> In the light of the evidence set forth [in the preceding pages of his article] only one answer can be made to the question as to the part the process defined by de Vries as 'mutation' is playing among higher animals to-day. Beyond doubt we have witnessed the birth of new species of birds during the past seventy years. Moreover, some of these new species have flourished so as to have become a salient part of the bird fauna in the region where they occur and where they were unknown to skilled ornithologists, who carefully studied these regions in the early part of the last century.

The birds here considered by Mr. Scott are nine in number, all from the 'Hypothetical List' of the American Ornithologists' Union Check-List of North American Birds, and, in the order of discovery, are as follows: Small-headed warbler (*Muscicapa minuta* Wilson, 1812), Blue Mountain warbler (*Sylvia montana* Wilson, 1812), carbonated warbler (*Sylvia carbonata* Audubon, 1831), Cuvier's kinglet (*Regulus cuvierii* Audubon, 1832), Townsend's bunting (*Emberiza townsendii* Audubon, 1834), Cooper's sandpiper (*Tringa cooperi* Baird, 1858), Brewster's linnet (*Acanthis brewsterii* Ridgway, 1872), Lawrence's warbler (*Helminthophaga lawrencei* Herrick, 1874), Brewster's warbler (*Helminthophaga leucobronchialis* Brewster, 1876). The first four of these birds are known only from the descriptions and figures given of them by Wilson and Audubon; of each of the next three, the original and still unique type specimen is preserved. The remaining two, both forms of *Helminthophila,* are known from numerous examples, they being of more or less frequent occurrence (if we reckon the variants of each) over a limited area in southern New England (mainly the lower Connecticut Valley), the lower Hudson Valley and northern New Jersey.

Mr. Scott comments on the first seven very briefly, but states, in concluding the enumeration, that he is compelled 'to consider these forms as mutations (which were not perpetuated) from species still existing.' About seven pages are then devoted to the remaining two forms, *Helminthophila leucobronchialis* and *H. lawrencei,* in which he gives a partial list of the known captures of each, mostly in footnotes in small type, with more or less extended extracts from the records relating to them, and often a summary of the opinions that have been expressed regarding the status and relationships of the two forms. The number of specimens of *H. leucobronchialis* at present extant is estimated to be 'at least 150,' and of *H. lawrencei* 'between 20 and 25.'

These two forms are discussed separately, at some length. Under *H. leucobronchialis* (*l. c.,* p. 278), he expresses his conclusions respecting them as follows:

[1] 'On the Probable Origin of Certain Birds,' by William E. D. Scott, SCIENCE, N. S., Vol. XXII., No. 557, Sept. 1, 1905, pp. 271–282.

In view of the foregoing facts, I am of the opinion that in *H. lecubronchialis* and in *H. lawrencei*, . . . we have examples of two separate and distinct 'mutations' from a common parent stock or species. That is, I believe that *H. pinus*, early in the last century became unstable as a species and began to throw off what must be considered as 'mutants,' taking de Vries's definition of the word. In other words, *H. pinus* is alone responsible and is the direct ancestor of both *H. leucobronchialis* and *H. lawrencei;* that these 'mutants' have up to the present time generally bred back into the parent stock, and that in so doing the instability of *H. pinus* has increased geometrically with the constant result of the increasing number of both kinds of 'mutants.'

While the 'mutation' theory may be a good hypothesis to consider in respect to these peculiarly unstable groups of birds, it must be noted that the method of their origin and the results, as now known, are very unlike the methods and results of mutation in plants, as made known by de Vries. The facts and conditions are not to any great extent parallel. Instead of the resulting 'mutants' remaining constant and breeding true, as in the case of primroses, they are in this case unstable and are believed[2] to interbreed freely with each other and the parent stock. Besides, in building up his theory of 'mutants' in the case of these warblers, we think Mr. Scott has belittled the evidence of hybridity and laid too much stress upon the (assumed) completeness of knowledge 'in the early part of the last century' of the ornithology of the area now inhabited by these birds. While it is true that most of these puzzling birds have been taken within the last twenty or twenty-five years, it does not follow that, as Mr. Scott says:

It is not likely that a form or kind of bird so common as *H. leucobronchialis* is at the present time, and ranging over as large an area as from Pennsylvania to Massachusetts and from Virginia to Michigan, should remain unknown to the earlier ornithologists, such keen field naturalists as Audubon and Wilson, Baird, Lawrence, Coues and Prentiss. Nuttall made careful and prolonged study of birds in the region where Mr. Brewster collected the type. Yet none of these close observers and good collectors either recorded or secured an individual of this kind. Clearly then, the presumption is that this bird could not have been so common early in the last century as it is now, if indeed it existed at all at that time.

First as to the range of these two forms, with reference to that given in the above quotation. *H. lawrencei* has been found only in the northern part of New Jersey, the lower Hudson Valley, and the lower Connecticut Valley. *H. leucobronchialis* has but five records (all of migrants) south of northern New Jersey, two of which are for southeastern Pennsylvania, two for the immediate vicinity of Washington, where collectors abound, and the other (not mentioned by Scott) for Louisiana. The bird has been reported as observed in northern Ohio, but the only record of a captured specimen for the region west of New Jersey and eastern New York is a single bird taken in southern Michigan. There are also only two records for the region north of Connecticut, which include the original type specimen (Newtonville, Mass., 1870) and one other (Hudson, Mass., 1858). Thus the known distribution of these forms, at least for the breeding season, is narrowed down to practically northern New Jersey, the southeast corner of New York (extreme lower Hudson Valley) and Connecticut. This is quite different from the distribution conditions that might be implied from the sweeping statement above quoted from Mr. Scott.

Now as to the work of the earlier naturalists. Both Wilson and Audubon explored the region around Philadelphia, where, notwithstanding all the careful field work of many expert collectors during recent years, there are only two records for *leucobronchialis* and none for *lawrencei*. These naturalists also each made journeys to New England, but their visits were brief and for the most part with other interests than field work, and it is well-

[2] By those who are most familiar with the facts. Interbreeding is known to occur between the two stock species, and also between their offspring and both of the stock species, and it has been repeatedly assumed by the best authorities that the hybrids are fertile *inter se*. This feature of the case is of course impossible of demonstration, owing to the nature of the conditions—the impossibility of continued observation of the same individuals for a series of years.

known that neither was accustomed to preserve, or even to collect, many specimens. Lawrence lived in New York City, and doubtless made frequent excursions into the adjoining country, but business exactions permitted little real field work comparable to that of present-day collectors and observers. In fact, his collection shows that he collected very few birds himself, but acquired them by purchase. Nuttall was a botanist and, although intensely interested in birds, if he ever collected many birds in the vicinity of his Cambridge home, the fact remains unrecorded. That his field work there in ornithology is to be compared with that of any one of the many enthusiastic collectors that have gleaned the region year after year for the last three decades is not to be even suggested. In any case, he worked, as already shown, practically outside of the range of these forms, since only two specimens have yet been obtained from eastern Massachusetts. Coues and Prentiss did their field work hundreds of miles distant from the principal range of these forms, and their collecting was casual and intermittent, in comparison with that of the numerous recent collectors in the Washington vicinage. Baird's field work, restricted to his early days, was also outside of the region here in question. Finally, the rapid increase in the number of these curious birds taken or observed during the last ten or fifteen years certainly has not more than kept pace with the greatly increased number of collectors of an expert class unknown 'in the early part of the last century.' There are now, within the area favored by these interesting birds, hundreds of private collections, each numbering more specimens of birds, nests and eggs, than all that had been collected in New England, New York and New Jersey prior to the middle of the last century. While there are now hundreds of persistent collectors within this prescribed area, one could probably count on the fingers of the two hands all those who have taken or observed in life any representatives of the two birds here in question. If Mr. Scott, who has done an exceptionally large amount of collecting in New Jersey and New England, has ever taken a specimen of either of these forms he seems to have neglected to record the fact of such an interesting capture. Evidently, then, the facts in the case fail to support the supposed rapid increase in the numbers of the birds in question alleged by our author to be so evident.

The ornithologists who are most familiar with these birds, through the examination of specimens and in life, have proposed or supported the theory of hybridity between *H. chrysoptera* and *H. pinus* as accounting in a fairly satisfactory manner for the birds, with their endless variants, known as *H. leucobronchialis* and *H. lawrencei*. But this does not seem to satisfy Mr. Scott, who says: "Nor does it seem that the theory of hybridity is supported when we consider the vast number of known specimens already in collections and the fact that it is possible to observe living specimens . . . each year." He further says: ". . . for, though hybrids do occur among wild birds, they can be considered at best as only casual, and the infertility of hybrids, especially among the higher animals, is too well known to need further comment here"! The case of *Colaptes cafer* and *C. auratus* must have, at this moment, escaped Mr. Scott's recollection, between which two species, for a thousand miles, north and south, along the line where their ranges meet, hybrids of all degrees, with every possible combination of the characters of these two strikingly different looking species are found almost to the exclusion of birds of pure blood of either species. The area of hybridity in this case occupies a belt hundreds of miles in width, the prevalence of birds presenting more or less traces of mixed blood gradually fading out both to the eastward and to the westward.

Mr. Scott makes only passing allusion to Dr. Bishop's important paper on this subject in a recent number of *The Auk* (XXII., January, 1905, pp. 21–24), and none to his conclusions, which are that *H. leucobronchialis* 'is merely a leuchroic phase of *H. pinus*, which, from its appearing frequently only within a very limited area, may in time become a species; and that *H. lawrencei* is a hybrid between *H. chrysoptera* and *H. pinus*.'

Near the end of Mr. Scott's paper, he quotes at considerable length from a paper recently

published in *The Ibis* (1903, pp. 11–18, pl. I.), by Professor H. H. Giglioli, entitled 'The Strange Case of *Athene chiaradiæ*,' a curious variant of *A. noctua*, having black instead of yellow irides, and some variations in the markings of the plumage from the normal form. The facts, and the speculations thereon by Professor Giglioli, are of much interest, and Mr. Scott thinks they help to confirm his view of the case of the two forms of *Helminthophila*. But the facts are not at all parallel, the nine specimens of the abnormal owl being traced back to, presumably, a single pair. This case has the essential features of a 'mutant,' as these peculiar owls were not the product of the union of two species, and hence not 'hybrids.' In other words, it is what Giglioli appropriately terms 'a case of *neogenesis*,' which might, should the progeny survive, constitute a new species. A further history of this case will naturally be awaited with great interest.

As already shown, I fail to see any good basis for Mr. Scott's attempt to employ the 'mutation' theory in explanation of the case of *H. lawrencei* and *H. leucobronchialis*, and believe still that these unstable and ever-varying forms are primarily the result of hybridity between *H. chrysoptera* and *H. pinus*, with which belief the known facts in the case are wholly consistent. Dichromatism may play a part, as several previous writers have suggested. The two forms are known to interbreed with each other and also with the parent stock, producing fertile offspring. They thus far, also, have been found (with the exception of a few migrating birds) only in the area where the breeding ranges of *H. chrysoptera* and *H. pinus* overlap. That they have not been found throughout this overlapping area is more than likely due to the absence from it of a sufficient number of expert observers. No section of the country within this range has a tithe of the expert field observers and collectors, proportionately to the area, that have been working for years throughout the limited district which has thus far almost exclusively produced the known examples of these birds. There seems to be no obvious reason why they should not occur sparingly westward over a narrow belt south of the Great Lakes to Wisconsin, where thus far they seem to have been almost wholly overlooked.

In taking up this subject, Mr. Scott appears to have proceeded without a very clear conception of either the essential facts of the warbler case or of the phenomena of 'mutants.' His assumption of the recent rapid increase of these forms rests on statements that are both misleading and irrelevant. The region of their occurrence is wholly outside of the fields of research of the ornithologists he mentions as evidence of the thorough knowledge of the ornithology of this region he assumes to have existed 'in the early part of the last century,' while, as regards numbers and methods, these early workers are not for a moment to be compared with those of the last few decades. Besides, it is only a few experts, who have made these birds a specialty, and know their haunts and notes, who have any success in their discovery. The facts, as already said, of the known relationships and the instability of these forms, harmonize poorly with the phenomena of mutations, shown by de Vries in relation to plants, in which the new forms arise with definite and stable characters, which they can transmit without modification to an apparently endless succession of generations. J. A. ALLEN.

SPECIAL ARTICLES.

BATTERY RESISTANCE BY MANCE'S METHOD.

AMONG the many methods for measuring battery resistance, one of the oldest, and apparently least understood, is that known as 'Mance's method.' As usually discussed in text-books this method is described as being a modification of Wheatstone's bridge, in which the cell to be measured takes the place of the unknown arm and the usual battery is replaced by a simple key. When opening or closing this key produces no change in the steady deflection of the galvanometer the bridge is balanced and, 'therefore, the usual relation of Wheatstone's bridge is satisfied.'. It is the object of this paper to show wherein many writers have erred in this explanation,

and to indicate a direct and simple derivation of the desired relationship.

Wheatstone's bridge consists, essentially, of two circuits in parallel through which an electric current can flow. Let these circuits be represented by *ABD* and *ACD*, Fig. 1, and

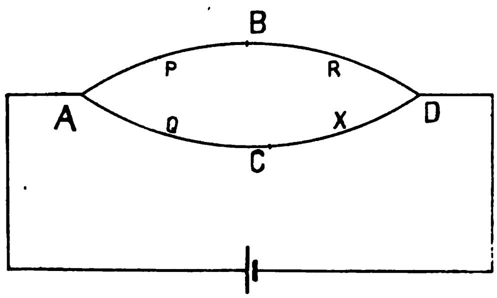

FIG. 1.

let the currents through the two branches be denoted by I and I'. Since the fall of potential from A to D is the same whichever path is considered, there must be a point C on one circuit, which has the same potential as any chosen point B of the other. If one terminal of a galvanometer is joined to B and the other terminal is moved along *ACD* the galvanometer will indicate zero deflection when the point C has been found. Since B and C have the same potential, the fall of potential from A to B is the same as from A to C, or in terms of the currents and the resistances,

$$IP = I'Q$$

where P and Q are the resistances of *AB* and *AC*, respectively.

Similarly for the other part of the circuits

$$IR = I'X.$$

Dividing one equation by the other gives

$$P:Q::R:X$$

as the relationship of the resistances when the bridge is balanced. In the usual method of using the Wheatstone bridge three of these resistances are known and the value of the fourth is easily computed from the above relation as soon as a balance is obtained.

In teaching 'Mance's method' the attempt has been made to deduce directly the expression for the resistance of the cell similarly to the above deduction for the Wheatstone bridge. Some three years ago a careful search of the literature was made, with the result that no direct and simple explanation of the method could be found, while the best authorities, German, English and American, either made statements which are absolutely false or passed over the subject in silence.

The first edition of Maxwell, published a few months after Mance's original paper, gives the method as follows (the italics are my own):

The measurement of the resistance of a battery when in action is of a much higher order of difficulty, since the resistance of the battery is found to change considerably for some time after the strength of the current through it is changed. In many of the methods commonly used to measure the resistance of a battery such alterations of the strength of the current through it occur in the course of the operations, and therefore the results are rendered doubtful.

In Mance's method, *which is free from this objection*, the battery is placed in *CD* and the galvanometer in *BC*. The connexion between A and D is then alternately made and broken. If the deflexion of the galvanometer remains unaltered

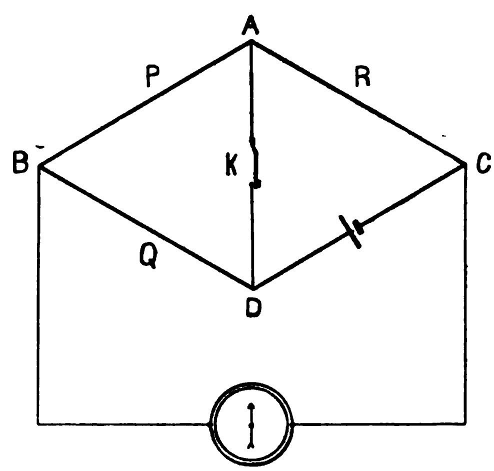

FIG. 2.

we know that *AD* is conjugate to *BC*, whence, $QR = PX$, and X, the resistance of the battery, is obtained in terms of known resistances P, Q, R. * * * In this method of measuring the resistance of the battery *the current in the battery is not in any way interfered with during the opera-*

tion, so that we may ascertain its resistance for any given strength of current, so as to determine how the strength of current affects the resistance.

A glance at Fig. 2 will show that in Mance's method the battery is joined in series with P, Q and R, and no two points having the same potential can be found on this circuit. The effect of closing K is to short-circuit P and Q, thus closing the battery through R alone, which frequently is not very large. Often the current from the cell is changed from a few ten-thousandths of an ampère to several tenths, *and this larger current flows through the key from A to D.* Thus it is readily seen that the points A and D are *not* at the same potential, and that the current in the cell is subject to considerable variation.

Lodge[1] pointed out this error in Maxwell and gives a very clear exposition of the method, but does not deduce any formula, concluding with the words:

> I have entered into this matter at some length because the slip in Maxwell is getting repeated in other books, and it is well to get clear on the subject.

Had all later writers read this admirable account the present paper would be unnecessary. But even after this clear exposition Maxwell has gone through two editions with the only result that the last paragraph quoted above now reads:

> In this method of measuring the resistance of the battery, the current in the galvanometer is not in any way interfered with during the operation, so that we may ascertain the resistance of the battery for any given strength of current in the galvanometer so as to determine how the strength of the current affects the resistance. [Which is meaningless.]

However, the makers of books have kept on as though nothing had been said, and some have fallen into a more grievous error in the attempt to deduce a formula for this method from its analogy with Wheatstone's bridge.

A standard English work written in 1887 says:

> In the Wheatstone bridge diagram, if the battery be placed in the X arm so as always to send a current through the galvanometer, then, by the principle of the bridge which we have already explained, when $P:Q=R:X$, the opening or closing of the key can have no influence on the current in the galvanometer, *inasmuch as the two points A and D are at the same potential.* This is the principle of Mance's method, in which adjustments are made of P, Q and R until the current in the galvanometer remains the same, whether the key is open or closed.

[1] O. J. Lodge, *Phil. Mag.*, 1877, Vol. 3, p. 515.

One of the largest and best German treatises, written in 1893, puts the matter more explicitly.

> But as no current can flow through the bridge (AD, containing the key) the potential at A is the same as at D, and the fall of potential over P is equal to that over Q and the fall of potential over R is equal to that over X. So then if there is no current through the bridge the same current, i, flows through the entire circuit BAC, and the current i' flows through the entire circuit BDC, and
>
> $$iP=i'Q,\quad iR=i'X,\quad P:Q=R:X,$$
>
> from which the desired resistance is obtained.

Of still more recent date are two American manuals, excellent in many respects, which follow the example set by the older books. One of these, written in 1898, puts the matter thus:

> If the cell, X, is placed in the branch CD of the bridge, and a key, K, inserted in place of the battery in the branch AD, there will, of course, always be a current through the galvanometer, and its needle will be deflected. But if, on making and breaking the key K, there is no change in this deflection, *A and D must have the same potential;* otherwise some of the current would have gone through AD when the key was closed and so a different quantity would have gone through the galvanometer. If, however, A and D have the same potential,
>
> $$P:Q::R:X.$$
>
> * * * Under this condition no current flows through the branch containing the key K.

The other book, written only last year, is simply another echo.

> The adjustment consists in finding such a point of contact, A, that opening and closing the bridge does not alter the galvanometer reading. Then *A and D are at the same potential*, and the re-

sistances are in the following proportion.

$$P : Q :: R : X.$$

It will now be of interest to turn to the original paper by Mance.[2] This was communicated to the Royal Society of London in 1871 by Sir Wm. Thomson. Mr. Henry Mance was superintendent of the Mekran Coast and Persian Gulf Telegraph Department and was especially interested in telegraph lines and cables and the detection of faults. He considers such a line, well grounded at each end and containing a battery and a galvanometer shunted by a circuit AB. The current through the galvanometer

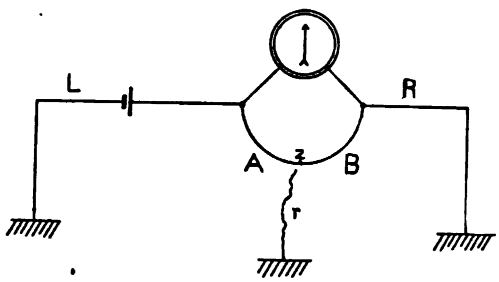

FIG. 3.

can be readily computed. But now let a leakage be applied to a point on the shunt. In general the deflection of the galvanometer will be changed, but by moving the leakage along AB a point can be found for which the galvanometer gives the original deflection. And this deflection will remain the same for all values of the leakage from 'dead earth' to infinity.

Presuming the electromotive E in L to remain constant, and taking $r = 0$, we have the intensity of the current passing through G represented by the equation

$$\frac{E}{\left\{L + \frac{G(A+B)}{G+(A+B)} + R\right\}\left\{\frac{G+(A+B)}{A+B}\right\}}$$

but after r is connected, the equation becomes

$$\frac{E}{\left\{L + \frac{\left(G + \frac{RB}{R+B}\right)A}{A + G + \frac{RB}{R+B}}\right\}\frac{G + \frac{RB}{R+B} + A}{A}}$$

[2] Henry Mance, *Proc. Roy. Soc. Lond.*, 1870, Vol. 19, p. 248.

As the condition that the galvanometer deflection remains unchanged, the first of these equations must be equal to the second, from which we obtain the formula

$$L = R\frac{A}{B},$$

the resistance G being immaterial. It will, therefore, be seen that R always bears the same proportion to L that B does to A, the latter bearing some analogy to the proportion coils of a Wheatstone testing bridge.

Mance proceeds to point out several applications of this method, concluding, 'lastly, this method may be used to ascertain the internal resistance of a battery.' There is nothing difficult or uncertain in this presentation and it seems strange that this original simplicity should have been so completely lost by later writers.

The clearest discussion of this method that I have seen in print is that given by Lodge in the paper referred to above, but this is descriptive rather than mathematical. However, he introduces a modification of the method which greatly increases the range of its application. This consists in using a condenser in series with the usual galvanometer, so as to detect variations in difference of potential instead of variations in current. By this means the method becomes a null one, and, moreover, the measurements can be made in a much shorter time as there is no waiting for the needle to come to rest in its deflected position. This is of especial advantage with cells which polarize rapidly. To eliminate the effect of any change in E.M.F. after the circuit is closed, Lodge devised a special key which broke the galvanometer connection immediately after the bridge circuit is made. It is better, however, to use a short-circuiting key on the galvanometer as suggested by Guthe.[3] The key is opened just before the discharge passes through the galvanometer and closed immediately afterwards to avoid any changes due to a variation in the E.M.F. of the cell.

However, as all cells polarize more or less rapidly, especially just after closing the cir-

[3] K. E. Guthe, 'Laboratory Exercises,' 1903.

cuit, it is not possible to work all the keys by hand quickly or uniformly enough to obtain the best results. By using a two-pole multi-circuit switch the various keys can be combined in one, and a single motion of the hand works them all in the order required. The switch *s* (Fig. 4) consists of two blades, *m*

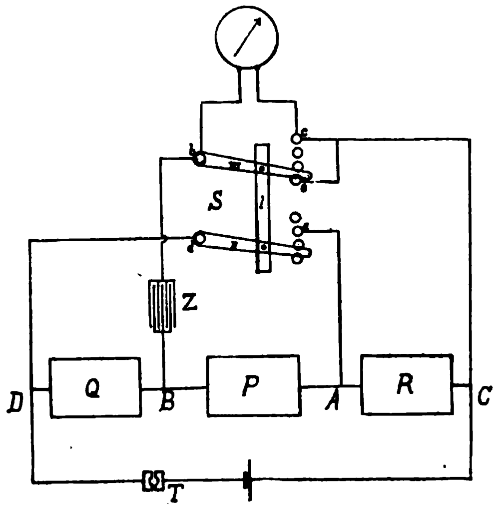

FIG. 4.

and *n*, pivoted at *b* and *d* and both moved by the connecting piece, *l*, over a series of four contact points. Thus, used as a two-pole switch, *b* and *d* can be connected to any one of four different circuits; but in the present case only a few of the contacts are utilized, and these are connected so as to make and break the various connections in the order desired as the switch is quickly moved from one side to the other.

The arrangement then is as follows: The cell, or other resistance to be measured, is joined in series with three resistances, *R*, *P* and *Q*, Fig. 4. The points *A* and *D* are joined to *a* and *d*, and are connected whenever *n* rests upon the third contact point. The galvanometer is joined to the points *b* and *c*, while *c* and *e* are permanently connected, thus short-circuiting the galvanometer when contact is made on either point, but when *m* is moved from *e* to *c* the short-circuit is raised for an instant. It is during this instant that the points *a* and *d* are connected by *n* passing over its third contact.

The points *b* and *c* are also joined to *B* and *C*, the former through the condenser *Z*. When the key *T* is closed this condenser is charged to the difference of potential between *B* and *C*, the charge passing through the blade *m* and leaving the galvanometer at rest. When the switch is thrown over to the third point, *A* and *D* are connected, which practically cuts *P* and *Q* out of the circuit, leaving only the battery and *R*. With this shorter circuit the condenser is charged to the difference of potential between *A* and *C* (since *D*, *B* and *A* are all at the same potential) and if this is the same as that formerly existing between *B* and *C* there will be no change in the charge and, therefore, no deflection of the galvanometer which, for this position of the switch, is not short-circuited. As the switch is moved further the galvanometer is short-circuited again before the connection *ad* is broken, thus eliminating the back kick of the galvanometer as the charge in the condenser returns to its former value.

Having set up the apparatus as indicated in the figure, the manipulation is as follows: The key *T* is closed and the switch quickly moved from *e* to *c*. If there is a deflection of the galvanometer the key is opened, the switch set back to its first position, and the values of *P* and *Q* changed until zero deflection is obtained when the switch is thrown. The arrangement is then 'balanced' and $X = R\,Q/P$.

This relation is easily deduced. The potential to which the condenser is charged in the first case, viz., that between *B* and *C*, is

$$e = I(R+P) = \frac{E(R+P)}{R+P+Q+X},$$

where *E* is the E.M.F. of the cell and *X* its resistance. When *P* and *Q* are short-circuited the condenser is charged to the difference of potential between *A* and *C*, which is

$$e' = RI' = \frac{ER}{R+X}.$$

When the galvanometer shows no deflection, $e = e'$, or

$$\frac{R+P}{R+P+Q+X}=\frac{R}{R+X},$$

which readily gives the relation

$$X=R\frac{Q}{P}.$$

It is true this result appears in the same form as that deduced for the Wheatstone bridge, but beyond a superficial analogy there is nothing in common between the two methods. The Wheatstone's bridge method consists in dividing two parallel circuits in the same ratio. Mance's method, on the other hand, consists in subtracting from the two portions of a single circuit such resistances that the two portions shall still maintain the same ratio to each other.

In this connection it may be of interest to look at the results of a few measurements by this method. The resistance measured consisted of a medium-sized storage cell in series with a coil marked '2 ohms.' This gives a definite resistance with an E.M.F. not easily polarized. The results of thirty measurements are shown in the table below. R was varied from one ohm to forty ohms, and P was given such values that Q would be a little over 4,000 ohms. Each balance was sensitive to a change of 1 ohm in Q, and often the 0.5-ohm coil was used. The results are tabulated in the order obtained, reading across the table from left to right. As the room became warmer the resistance grew larger, each column showing the same increase of 0.002 ohm. It is seen from these results that the method is as sensitive as a post-office box, and by using a larger condenser the sensitiveness can be still further increased. From this limited data it is hardly safe to draw a general conclusion, but it may be noted that the smaller values of R, in other words, the larger currents in the storage cell, give smaller values of X, the same as with ordinary cells.

Temperature of Room.	Resistance of '2 Ohms' Plus Storage Cell.					
	$R=1.$	$R=2.$	$R=3.$	$R=4$	$R=10.$	$R=40.$
12.°0	2.0265	2.0280	2.0295	2.0295	2.0300	2.0300
12.°6	2.0265	2.0290	2.0305	2.0310	2.0315	2.0320
13.°0	2.0280	2.0297	2.0315	2.0312	2.0315	2.0320
13.°2	2.0282	2.0300	2.0315	2.0315	2.0317	2.0320
13.°5	2.0285	2.0302	2.0315	2.0315	2.0317	2.0320

The following results were obtained from a large 'Gonda' cell, a porous cup type of Leclanche cell. It had been in constant use in the laboratory for five months with no change of electrolyte. As it polarized rapidly for the first ten seconds after closing the circuit through one or two ohms, its resistance was measured with values of R of 40, 60 and 80 ohms. The values obtained were as follows:

Temperature of Cell.	Resistance of 'Gonda Cell.'		
	$R=40.$	$R=60.$	$R=80.$
13.°0	1.388	1.386	1.388
	1.392	1.392	1.388
	1.392	1.392	1.384
13.°2	1.389	1.392	1.388

The average of these twelve determinations is 1.389 ohms, and the mean variation from this value is 0.002 ohm, while the probable error of this result is 1 part in 2,600.

But it is not my present purpose to discuss experimental data except in so far as it shows that Mance's method is not without some merit. It has been shown that this method is fully as accurate as is required for laboratory use, whether the resistance to be measured be of the first or second class. The purpose of this paper will be fully attained if it has clearly shown the principle underlying this method, and pointed out the very obvious error which has crept into many of the text-books from Maxwell down to the present.

Arthur W. Smith.
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Ann Arbor, Mich.,
February 11, 1905.

ORGANISMS ON THE SURFACE OF GRAIN, WITH SPECIAL REFERENCE TO BACILLUS COLI.

The recent note by Dr. Erastus G. Smith on the occurrence on grain of organisms resembling the *Bacillus coli communis*[1] appears to warrant preliminary publication of some of the results of my studies of the micro-organisms normally present on the flowers and fruit of certain plants in the Piedmont region and the rice belt of South Carolina. These studies, originally undertaken as a side issue

[1] Science, May 5, 1905.

in another problem, have proved intrinsically interesting.

In the fall of 1903 I determined the organisms present on the grain in twelve rice fields. In 1904 I studied both the flowers and grain in eight of the twelve fields examined the year before, and in four other fields. In 1904 I also studied, for comparison, the flowers and grain in eight wheat fields, and six oat fields; also the flowers and fruit in three peach orchards, flowers and fruit in two asparagus patches, and flowers and fruit in one patch of the wild *Iris verna* L. A few comparative studies of organisms on the fruit or flowers and the leaves of the same plant were also made. In every case exactly fifty grains or flowers or fruits, as the case might be, were taken at random from each field or patch, in the case of the cereals only one grain from any one spike. Each one was shaken in sterile water, allowed to stand for about an hour, shaken again, and the whole added to sterile agar-agar and plated; except in the case of peaches, when only a portion of the water was plated. The resulting organisms were studied in greater or less detail, according to their interest.

A part of the conclusions to date are as follows:

1. An immense but variable number and variety of micro-organisms were normally present on the surface of flowers, fruits and leaves. These were different in different localities, and different in successive years in the same locality, and showed no constant association with the host plants studied.

2. Without exception, the same organisms that occurred on the flower could later be found on the fruit, but not in the same quantity. But organisms commonly occurred on the fruit that were not found on the flower.

3. The most constantly present organisms were certain yeasts; in greatest number and variety on the peach, asparagus and iris; but yet characteristically present on the cereals.

4. The bacteria on the flowers and fruit were not different in kind from those on the leaves of the same plant, nor, so far as studied, materially different in number, area for area. With the peach, asparagus and iris fungi, and especially yeasts, occurred in noticeably greater number on the flower and fruit than on the leaf.

5. Bacteria giving the standard reactions of the colon group were found in thirteen out of the sixteen rice fields examined, five of the eight wheat fields and all of the oat fields. All three peach orchards and both asparagus patches exhibited coli forms in both flower and fruit; but none were found on either flower or fruit of *Iris verna*. In the following tables are shown the proportion of flowers and fruits (each flower or grain in the cereals representing a spike) found to have coli forms on the surface:

Rice: No. of Field.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Per cent. of spikes with coli forms, 1903.	0	10*	2	16	20	0	26	32	0	30*	0	6	—	—	—	—
Ditto, flowers, 1904	0	—	22*	8	38	4	—	8*	6	—	0	—	10	48*	6	0
Ditto, grains, 1904.	0	—	48*	4	52	8	—	14*	2	—	0	—	28	30*	4	0

Wheat: No. of Field.	1	2	3	4	5	6	7	8
Per cent. of spikes with coli forms, flowers	6	4	0	14*	0	0	8	26*
Ditto, grains	2	6	0	22*	0	0	2	18

Peaches: No. of Orchards.	1	2	3
Per cent. of flowers with coli forms	16*	8*	20
Ditto, fruits	24*	12*	14

Oats: No. of Field	1	2	3	4	5	6
Per cent. of spikes with coli forms, flowers	6	8	2*	14*	31	4
Ditto. grains	2	0	4	10	28	2

Asparagus: No. of Patch.	1	2
Per cent. of flowers with coli forms	58*	26
Ditto, fruits	40	16

An asterisk indicates that there were in the field in question very obvious means of contamination by human or animal excrement at

the time the plates were made. In the other fields the source of the coli forms was without doubt the excrement deposited by draft-animals in working the ground, to say nothing of that deposited on the banks and adjacent secluded spots by workmen. Indeed, the nonoccurrence of coli forms in certain fields seems most difficult to explain.

These studies are being continued, and when completed, will be published probably in the *Centralblatt für Bakteriologie*.

HAVEN METCALF.

CLEMSON A. & M. COLLEGE,
SOUTH CAROLINA.

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.[1]

IN 1903 I was appointed by the council of this society acting as the regional bureau for New South Wales, to represent this state at the council meetings held in London in May last. I duly attended the meetings and now have the honor to make the following report. The Royal Society of London commenced the work by compiling catalogues of scientific papers (printed between 1800 and 1883) in twelve large quarto volumes, the first volume of which was issued in 1867. In it the titles are arranged solely under the authors' names. A catalogue of the papers published since, *i. e.*, between 1884 and 1900, is now in hand, and a subject index is also nearly completed.

The possibility of preparing a complete catalogue of current scientific literature was considered by the Royal Society in 1893, but as it was apparent that the work was beyond the resources of the Royal Society, or indeed of any single body, the society sought the opinion of representative foreign bodies and individuals, and the replies being favorable, steps were taken to summon an international conference. This conference, at which I was present as a delegate, took place in London, on July 14 to 17, 1896, and was attended by delegates appointed by the governments of Canada, Cape Colony, Denmark, France, Greece, Hungary, India, Italy, Japan, Mexico, Natal, the Netherlands, New South Wales, New Zealand, Norway, Queensland, Sweden, Switzerland, the United Kingdom and the United States. It was then unanimously resolved to compile and publish a complete catalogue of current scientific literature, arranged according to both subject matter and authors' names. The Royal Society was requested to appoint a committee to further consider the system of classification to be adopted and other matters, and it was decided to establish the central bureau in London.

At the second international conference held in London on October 11 to 13, 1898, several questions were settled and a provisional international committee appointed which afterwards met in London, on August 1 to 5, 1899, when the work was still further expedited and the Royal Society requested to organize the central bureau and make all necessary arrangements so that the preparation of the catalogue might be commenced in 1901.

A third international conference was held in London, on June 12 and 13, 1900, at which all financial and other difficulties were removed by the Royal Society agreeing to act as publishers and to advance the funds necessary to start the enterprise. The supreme control over the catalogue is now vested in an international convention which is to meet in London in 1905, in 1910 and every tenth year afterwards, to consider and, if necessary, to revise the regulations for carrying out the work of the catalogue. In the interval between two successive meetings of the convention the administration of the catalogue is carried out by the international council, the members of which are appointed by the regional bureaus.

The total expenditure from July 1, 1900, to February 29, 1904, has been £10,153, and the total amount received from subscribing bodies was £6,755; eventually the publication will pay its way, but it may be some time before the debt to the Royal Society will be extinguished. The financial support given by the different countries is shown in the following list. New Zealand has not become a contracting body: Austria, £165; Canada, £119; Cape Colony,

[1] Report presented at the annual general meeting of the Royal Society of New South Wales, May 3, 1905.

£109; Denmark, £102; Egypt, £17; Finland, £45; France, £754; Germany, £901; Greece, £34; Holland, £133; Hungary, £68; India and Ceylon, £471; Italy, £459; Japan, £255; Mexico, £85; New South Wales, £34; New Zealand, £17; Norway, £85; Nova Scotia, £17; Orange River Colony, £17; Poland, £17; Portugal, £17; Queensland, £34; Russia, £512; South Australia, £34; Sweden, £85; Switzerland, £119; United Kingdom, £765; United States, £1,251; Victoria, £17; Western Australia, £17. Total, £6,755.

	Slips.	Instalments.
Germany	146,552	59
France	46,702	38
United Kingdom	43,484	166
United States	37,688	68
Russia	21,071	5
Italy	13,473	25
Holland	6,657	17
Austria	6,379	2
Poland	3,492	8
India and Ceylon	2,231	39
Japan	2,208	10
Switzerland	1,932	7
Hungary	1,745	4
Denmark	1,722	17
Sweden	1,457	4
Victoria	1,445	3
Norway	1,303	12
New South Wales	1,016	5
Finland	707	8
South Africa	645	4
Belgium	584	2
Canada	537	11
New Zealand	327	3
South Australia	130	4
Western Australia	16	1
	343,503	522

It has been suggested that special efforts should be made by the regional bureaus to bring the catalogue under the notice of scientific workers, and to secure an increase in the number of subscribers. The whole of the first and second issues of the 'International Catalogue of Scientific Literature' have been published with the exception of the volumes on botany and zoology; the third annual issue is in preparation and several of them are already in the press. The number of entries in the author catalogue of the first annual issue was 43,447, and the total number of entries in that issue was 149,768. The numbers of books and papers indexed in the volumes of the second annual issue are as follows: A, mathematics, 1,843; B, mechanics, 841; C, physics, 2,433; D, chemistry, 5,632; E, astronomy, 1,223; F, meteorology, 1,988; G, mineralogy, 1,307; H, geology, 1,702; J, geography, 2,022; K, paleontology, 638; L, general biology, 689; M, botany, 6,339; N, zoology, 7,131; O, anatomy, 1,424; P, anthropology, 1,861; Q, physiology, 9,671; R, bacteriology, 3,132. The total number of entries in the author catalogue of the second annual issue is, therefore, 49,876, an increase of 6,429, or about 15 per cent. more than the number in the first annual issue. The total number of pages in the first annual issue is 8,387.

The foregoing table shows the number of slips *received* and the instalments in which they were supplied to the central bureau.

It was originally intended that the catalogue should not only contain the titles of papers, but that their subject matter should be fully indexed also; financial considerations have, however, led to the number of subject entries being at present limited in number. The title slips received at the central bureau very often showed that the papers were insufficiently indexed, especially in the lists of new species in botany, zoology and chemistry; in many cases the central bureau has made good these deficiencies. The executive committee urge that efforts should be made in all countries to supply fuller information as to the contents of papers; if this were done the catalogue would be much more complete and the cost would be much decreased, and all journals are urged to index each paper and attach the registration numbers at the time of publication.

At the meeting of the international council held at the Royal Society's House, London, May 23 and 24, 1904, it was resolved, in consequence of the success achieved by the 'International Catalogue of Scientific Literature,' and of its great importance to scientific workers, to recommend that its publication be continued. The agreement with the contract-

ing countries was made in the first instance for five years only, in case the publication of the catalogue should fail financially or in other ways. It was also decided to spend £100 in making the catalogue known, and to take steps to invite the cooperation of other countries not yet represented on the council, *e. g.*, Spain, the Balkan States, South American Republics, etc.

The proposal to publish additional volumes upon, *a*, medicine and surgery; *b*, agriculture, horticulture and forestry; *c*, technology (various branches) was discussed, and it was decided that the executive committee should take the suggestion into fuller consideration and bring it under the notice of the international convention in July, 1905. It was also resolved that all alterations in the schedules should be collected and edited by the central bureau prior to submission to the regional bureaus for their opinions, and that the schemes should be edited by a special committee before being submitted to the international convention.

A. Liversidge.

INAUGURATION OF THE MAGNETIC SURVEY OF THE NORTH PACIFIC OCEAN.

As announced in a previous issue of Science, the brig *Galilee* of San Francisco, a wooden sailing vessel, built in 1891, of length 132.5 feet, breadth 33.5 feet, depth 12.7 feet, displacement about 600 tons, has been chartered by the department of terrestrial magnetism of the Carnegie Institution of Washington for the purpose of making a magnetic survey of the North Pacific Ocean. After the various necessary alterations, *e. g.*, substitution of the steel rigging by hemp rigging, etc., were made, the vessel entered upon her duties early in August. Magnetic observations were made at various places on the shores around San Francisco Bay and the most suitable place for 'swinging ship' by their aid determined. The ship was 'swung' with the aid of a tug on August 2, 3 and 4 in San Francisco Bay between Goat Island and Berkeley, California, and the various deviation coefficients were determined.

On August 5, the *Galilee* sailed from San Francisco, secured magnetic observations daily to a greater or less extent according to conditions of the weather and sea, 'swung' twice under sail, and arrived at San Diego, August 12. This first short cruise was an experimental one, various instruments and methods having been subjected to trials under the direction of the writer, who accompanied the expedition as far as San Diego. The deflection apparatus devised by the writer for determining horizontal intensity has proved successful. In a future paper the methods, instruments and results will be more fully described.

After further alterations had been made at San Diego, and the deviation coefficients having been redetermined, the *Galilee* again set sail, on September 1, this time for the Hawaiian and Midway Islands and is expected to return to San Francisco about December 1. After these two experimental voyages, she is to sail from San Francisco early in 1906 on a more lengthy cruise—one embracing the entire circuit of the North Pacific Ocean.

The scientific personnel at present consists of Mr. J. F. Pratt, commander; Dr. J. Hobart Egbert, surgeon and magnetic observer; Mr. J. P. Ault, magnetic observer, and Mr. P. C. Whitney, magnetic observer and watch officer. The sailing master is Captain J. T. Hayes, who has made some record sailing trips in the *Galilee*—one a voyage of 3,000 miles from the South Pacific Islands to San Francisco in fifteen days and having made as much as 308 miles in one day.

L. A. Bauer.

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Washington, D. C.,
September 11, 1905.

EXPERIMENTAL STUDIES IN YELLOW FEVER AND MALARIA AT VERA CRUZ.

The U. S. Public Health and Marine Hospital Service has published a bulletin on the experimental work done by assistant surgeons M. J. Rosenau, Herman B. Parker, Edward Francis and George E. Beyer, the conclusions of which are as follows: The cause of yellow fever is not known. The *Myxococcidium*

stegomyiæ is not an animal parasite. Yeast cells sometimes stimulate the coccidia in form and staining reaction.

The infection of yellow fever is in the blood serum early in the disease. No abnormal elements that bear a causal relation to the disease can be detected in the serum or in the corpuscles with the best lenses at our command.

The infective principle of yellow fever may pass the pores of a Pasteur-Chamberland B filter. Particles of carbon visible with Zeiss lenses pass through both the Berkefeld and Pasteur-Chamberland B filters. Because the virus of an infectious disease passes a Berkefeld or Pasteur-Chamberland B filter it does not necessarily follow that the parasite which passed the filter is 'ultramicroscopic,' or that it may not have elsewhere another phase in its life cycle of large size. The filtration of viruses may succeed or fail, depending upon the character of the filter, the diluting fluid, the pressure, time, temperature, motility of the particles and other factors.

The period of incubation of yellow fever caused by the bites of infected mosquitoes is usually three days, sometimes five days, and in one authentic instance six days and two hours; but when the disease is transmitted by such artificial means as the inoculation of blood or blood serum the period of incubation shows less regularity.

Yellow fever may be conveyed to a non-immune by the bite of an infected *Stegomyia fasciata;* but the bites of *Stegomyia* which have previously (over twelve days) bitten cases of yellow fever do not always convey the disease.

Fomites play no part in the transmission of the disease.

The tertian and estivo-autumnal malarial parasites will not pass the pores of a Berkefeld filter.

There is a poison in the blood during the chill of tertian infection which, when injected into another man, caused chill, fever and sweating. This poison, while present in a case of tertian during the rise of temperature, could not be demonstrated in the blood of a case of estivo-autumnal fever during the decline of the paroxysm. While this poison reproduced the symptoms of the disease, still the data are too limited to consider it the malarial toxin.

Stegomyia fasciata is a domestic insect. It is most active during the day, but will bite at night under artificial light. The female lays eggs at intervals; the maximum number of eggs laid by one insect observed was 101. The mosquito does not always die directly after ovipositing.

Stegomyia fasciata may bite and draw blood from cadavers, although the danger from spreading the infection from this source is remote.

Male and female *Stegomyia fasciata* may pass a screen containing 16 strands, or 15 meshes to the inch, but not one of 20 strands, or 19 meshes to the inch.

Tobacco smoke produced by burning two pounds per 1,000 cubic feet with an exposure of two hours is sufficient to kill *Stegomyia fasciata.* This method is objectionable on account of the yellow stains and disagreeable odor. Pyrethrum burned in the proportion of one pound per 1,000 cubic feet with an exposure of two hours will stupefy *Stegomyia fasciata;* it requires two pounds to kill them outright.

From the limited number of experiments made and from previous experiments it is thought that sulphur dioxid is the best of the gaseous insecticides for this purpose. Formaldehyde gas is not an insecticide, and therefore not applicable.

SCIENTIFIC NOTES AND NEWS.

M. Élie Metchnikoff, of the Institut Pasteur, has been elected a foreign member of the Brussels Academy of Sciences.

Dr. Karl Schwarzschild, professor of astronomy at Göttingen, has been elected a member of the Academy of Sciences of that city.

Brig. General A. W. Greely, chief signal officer of the army, has completed a thorough inspection of the Alaskan telegraph system.

Dr. Otto Klotz, Dominion astronomer, has just completed observations at Harvard Observatory for the longitude connections with the new observatory at Ottawa.

PROFESSOR PODWYSSOTZKI, dean of the medical faculty of Odessa, has been appointed director of the Institute for Experimental Medicine at St. Petersburg.

DR. HERMAN S. DAVIS, after six years' investigation of the variations of latitude for Columbia University, New York, and five years' for the International Geodetic Association, retires from this line of research on November 1, on which date his resignation as director of the observatory at Gaithersburg, Maryland, takes effect.

THE following members of the advisory board of Panama Canal engineers have sailed for the Isthmus on the steamship *Colon:* Gen. George W. Davis; William Barclay Parsons; Professor W. H. Burr, of Columbia University; Gen. Henry H. Abbott; Eugene Tincauzer, German delegate; Edouard M. Quellenac, of the Suez Canal staff; Isham Randolph; F. P. Stearns; Joseph Ripley; W. H. Hunter, of the Manchester Canal; Adolph Guerard, French delegate; J. W. Welcker, Dutch delegate, and Capt. John C. Oakes, secretary.

A CABLEGRAM from London states that William P. Byrne, principal clerk of the home office; Dr. Horatio B. Donkin, a commissioner of prisons and consulting physician to Westminister Hospital; Dr. William H. Dickinson, consulting physician to St. George's Hospital and former president of the Royal Medical and Chirurgical Society; J. C. Dunlop and Mrs. Pinsent, composing the sub-committee of the Royal Commission on the care and control of the insane, sailed from Liverpool for New York, on September 30, on the Cunard Line steamer *Etruria,* to investigate American methods of treating the insane.

DR. H. P. BOWDITCH, professor of physiology at the Harvard Medical School, has been granted leave of absence for the coming year.

THE Herter Lectures, established by Dr. C. A. Herter at the New York University and Bellevue Hospital Medical College, will be given this year by Professor Carl von Noorden, chief of the City Hospital, of Frankfort, Germany. His subject will be 'Diabetes.' The lectures, six in number, will be given in English in the large auditorium of the Carnegie Laboratory, 338 East 26th Street, October 9 to 14, inclusive, at 4 o'clock in the afternoon. Visitors are welcome to these lectures. Reserved seats are to be had on application to the college.

AT the first fall meeting of the New York Academy of Sciences, Professor Robert W. Hill will lecture on 'The Republic of Mexico, its Physical and Economic Aspects.' The lecture will be given in the large lecture hall of the American Museum of Natural History, and all interested are invited to attend.

THE Harben Lectures of the Royal Institute of Public Health will be delivered in the lecture room of the institute, on October 10, 12 and 17, by Professor Thomas Oliver, physician to the Royal Infirmary, Newcastle-on-Tyne. The subject of the lectures will be, 'Some of the Maladies caused by the Air we Breathe in the Home, Factory and the Mine, including a Description of Caisson Disease or Compressed Air Illness.'

PROFESSOR WILLIAM OSLER, regius professor of medicine at Oxford University, has accepted the post of Thomas Young lecturer on medicine at St. George's Hospital, and will give a series of lectures and demonstrations at the hospital next spring on the diagnosis of abdominal tumors.

DR. A. M. FAIRBAIRN, principal of Mansfield College, Oxford, England, who has accepted an appointment as Deems lecturer at New York University, will deliver his course of lectures in January.

PROFESSOR CHARLES SCHUCHERT, of Yale University, has returned from a geological trip extending over the ancient formations of Nova Scotia, New Brunswick and eastern Quebec.

A CABLEGRAM to the daily papers states that Mylius Ericksen is preparing a Danish ship and a sledge party for an expedition to the hitherto unexplored regions of the northeastern coast of Greenland. The plans have been in course of elaboration since Ericksen's return from his last expedition, and have been approved by many societies, including the American Geographical Society and the Royal

Geographical Society of London, and also by Dr. Nansen, Professor von Drygalski and other scientific men.

American Medicine states that during the epidemic in New Orleans an opportunity has been afforded for careful study of conditions leading to the infection, with the result, it is believed, that the causative microorganism has been isolated and identified. The work has been conducted at the emergency hospital by Drs. P. E. Archinard, J. Birney Guthrie and J. C. Smith. The life history of the organism discovered by Dr. Archinard has been followed, and its presence in the blood of patients confirmed.

SIR THOMAS BROWNE, the author of 'Religio Medici,' was born on October 19, 1605, and the quatercentenary will be celebrated at Norwich on the same date this year. *The British Medical Journal* states that the memorial statue of Sir Thomas Browne, erected in the Market Place, will be unveiled at 12:30 P.M. by Lord Avebury, F.R.S.; afterwards a luncheon will be held at the Blackfriars Hall. At 8:30 P.M. there will be a service in memory of Sir Thomas Browne in the Church of St. Peter Mancroft, Norwich, near which he lived for many years, and in which he worshipped, and lies buried; the sermon will be preached by the Right Rev. Bishop Mitchinson, master of Pembroke College, Oxford, of which college Sir Thomas Browne was a member.

DR. ALFRED SCHAPER, assistant to the professor of embryology at Breslau, has died at the age of forty-two years.

THE deaths are also announced of Dr. Franz Ruch, docent in geodesy in the Technical Institute at Prague, and of Dr. Rudolf Pernthner von Lichtenfelds, docent in architectural engineering in the Polytechnic Institute at Vienna.

THE second general international sanitary convention will meet in Washington on October 9. The different South American republics will be represented, and many European men of science will be in attendance.

A CIVIL SERVICE examination will be held October 25, 1905, to establish a register of eligibles from which to fill four positions as laboratory assistant in the Bureau of Standards, Washington. Three of these positions are in the Electrical Division of the Bureau and one in Weights and Measures; the salaries are $900 and $1,000. The examination will consist of:

Education and experience (rated on application form)	50
General physics	25
Special subjects (it is optional with the competitor to take more than one of these subjects)—(*a*) electrical measurements; (*b*) weights and measures	25
Total	100

Any one wishing to take the examination should address the U. S. Civil Service Commission requesting application blanks. Further information may be obtained by addressing the director of the Bureau of Standards. Applicants must be between 20 and 35 years of age.

THE Smithsonian Institution has received information through the Department of State, from Consul General George Heimrod, of Apia, Samoa, that between August 2 and 4, last, a new volcano broke out in Savaii, about eight miles east of the old volcano Mangi, and ten miles south of Matautu. Mr. Heimrod states that the activity of this volcano is phenomenal, as in a single fortnight it created a new mountain with three peaks, one of which will soon reach a height of 800 feet or 2,000 feet above sea-level. The ejected matter represents many millions of tons of unsmelted rocks, slag, cinders and ash, which at the beginning of the outbreak in its fiery state was moving towards the sea, the settled part of the island. The mass is about five miles long and one fourth of a mile wide, and as it has almost come to a standstill and is hardening at its extreme ends, danger for life and property is not anticipated.

IN connection with the Conservatoire des Arts et Métiers a museum of industrial hygiene will be opened this month at Paris by the president of the republic.

ACCORDING to *The Journal of the Society of Arts* the British consul at Naples reports that the work on the new wing which is being

added to the Stazione Zoologica is making rapid progress. When completed the capabilities of the institution for scientific investigation in connection with fishing and other questions will be more than doubled, and the extension would seem to be much wanted, for during the spring months of the present year no less than seventy naturalists of all nationalities were engaged in various researches, and fifteen applicants had to be refused admission on account of the lack of accommodation. The completion of the new building, the ground plan of which measures 110 by 77 feet, will permit the following improvements to be made: (1) The unique library of books on marine biology will be brought together upon the same floor instead of being distributed in various rooms; (2) laboratories and workrooms equipped under the superintendence of Dr. Henze for research in the physiological chemistry of marine animals will be the best and largest of their kind, and will occupy the second floor of the new building; (3) laboratories and workrooms for other physiological work in connection with marine animals will occupy the first floor; (4) a new photographic and artists' room will be gained; (5) a bacteriological laboratory; (6) some thirty new rooms for private study. The basement will be occupied by enormous aquaria and tanks, with the necessary engines for working the circulating pumps and for supplying power to the engineer's shop.

THE Wagner Free Institute of Science, Philadelphia, announces the following courses of lectures: Professor Samuel T. Wagner, 'Roads, Railroads and Tunnels'; sixteen lectures, as follows: September 15, 22, 29; October 6, 13, 20, 27; November 3, 10, 17, 27; December 1, 8, 15, 22, 29. Dr. Philip P. Calvert, 'The Development and Life Histories of Invertebrate Animals'; ten lectures, as follows: October 2, 9, 16, 23, 30; November 6, 13, 20, 27; December 4. Professor Henry Leffmann, 'Metals and Ores'; ten lectures, as follows: October 4, 11, 18, 25; November 1, 8, 15, 22, 29; December 6. Professor Wm. B. Scott, 'Physiographical Geology'; sixteen lectures, as follows: January 3, 10, 17, 24, 31; February 7, 14, 21, 28; March 7, 14, 21, 28; April 4, 11, 18. Professor Geo. F. Stradling, 'Electricity'; sixteen lectures, as follows: January 5, 12, 19, 26; February 2, 9, 16, 23; March 2, 9, 16, 23, 30; April 6, 20, 27. Dr. John W. Harshberger, 'North American Trees'; ten lectures, as follows: February 5, 12, 19, 26; March 5, 12, 19, 26; April 2, 9.

THE policy of holding annually a meeting of the principal engineers of the Reclamation Service for the purpose of discussing matters of administration and economies of work seems to have become well established. The reclamation act was signed by the president, on June 17, 1902. An engineering corps consisting of well-trained and experienced men has been gradually selected through the Civil Service Commission to meet the needs of the service, and the work of reclamation has been energetically pushed in all parts of the arid region. The first conference of engineers was held at Ogden, Utah, September 15 to 18, 1903, in connection with the eleventh Irrigation Congress. The first session of the second conference was held at the time of the meeting of the twelfth Irrigation Congress, at El Paso, Texas, November 14 to 18, 1904. On this occasion the principal engineers of the Reclamation Service met prominent citizens from the west and exchanged views with them regarding reclamation matters of common interest. The conference adjourned to meet in Washington in January, 1905, in order to allow opportunity for other engineers to take part in the discussions and to give additional time for consideration of important details. At the adjourned meeting in Washington a number of prominent public men met the engineers and exchanged views concerning matters in various states. The discussions that occurred at this meeting and the papers presented then constitute a very valuable body of material. The printed report of the proceedings of the first conference, that at Ogden, was distributed as Water-Supply and Irrigation Paper No. 93 and was found to be of great assistance to the men engaged in reclamation work. On the recommendation, therefore, of Mr. F. H. Newell, chief engineer,

the proceedings of the second conference have been collected and published by the United States Geological Survey. They are now available as Water-Supply and Irrigation Paper No. 146, and may be obtained free of charge on application to the director of the Survey, Washington, D. C. Besides data concerning the organization of the hydrographic branch of the Geological Survey and the Reclamation Service, the paper contains the minutes of the conference at El Paso and the conference at Washington, the address of the chief engineer, the papers read at the conference, committee reports, circulars relating to a variety of subjects, and brief biographical sketches of all persons employed in the Reclamation Service.

UNIVERSITY AND EDUCATIONAL NEWS.

Mr. James Millikan, who has given $900,000 for the establishment of a university at Decatur, Ill., which shall bear his name, has offered to give a further million dollars to the institution.

Major Henry E. Alvord, the late chief of the dairy division of the Department of Agriculture in Washington, divided his library between Norwich University, of Vermont, his alma mater, and the Massachusetts Agricultural College at Amherst. To the latter institution he bequeathed also a fund of $5,000 for an Alvord dairy scholarship. This, however, is subject to the life interest of his widow.

According to the *New York Evening Post* Dr. Kisaburo Yamaguchi, an official in the Central Office of Mines, Tokio, has announced that Johns Hopkins will be made the recipient of an extensive collection of Japanese minerals.

Dr. John N. Tillman was inaugurated as president of the University of Arkansas, at the opening of that institution, on September 20.

Dr. William Louis Poteat, for some years professor of biology in Wake Forest College, North Carolina, was recently elected president of the same institution. It is proposed to have the inaugural exercises in December.

At the University of Illinois James McLaren White, professor of architectural engineering, has been appointed acting dean of the College of Engineering; Edgar J. Townsend, associate professor of mathematics, acting dean of the College of Science, and Dr. Edwin G. Dexter, professor of education, director of the School of Education. Appointments have further been made as follows: Professor S. E. Slocum, assistant professor of mathematics; F. O. Dufour, of Lehigh University, assistant professor of civil engineering; C. H. Hurd, University of Chicago, assistant professor of applied mechanics; Edward O. Sisson, formerly director of Bradley Polytechnic Institute, Peoria, and Frank Hamsher, principal of academy, assistant professors of education; Dr. Edward Barto, associate professor of chemistry and director of water survey; W. J. Risley, University of Michigan, instructor in mathematics and astronomy; John Watrous Case, Massachusetts Institute of Technology, instructor in physics.

Dr. Leo F. Guttman, of London, for two years research assistant to Sir William Ramsay, has arrived from abroad to take up his duties as Carnegie research assistant to Professor Charles Baskerville, of the College of the City of New York, in his chemical investigations of the rarer earths.

Dr. Wilhelm F. Koelker, who recently took his degree with Professor Emil Fischer at the University of Berlin, has been appointed instructor in organic chemistry at the University of Wisconsin.

Mr. C. G. Eldredge, of Sabula, Iowa, has been appointed assistant in the chemical department of Cornell College.

Dr. H. A. Higbee and Dr. Roger C. Wells have been appointed instructors in physics in the University of Pennsylvania.

Provision has been made for a professorship of botany at the University of Melbourne and for the erection of a botanical laboratory.

Dr. Konrad Dietrici, of Hanover, has been called to the chair of physics at Rostock.

Professor O. Pumlirz, of Czernowitz, has been called to the chair of mathematical physics at Innsbruck.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, OCTOBER 13, 1905.

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

RECENT DEVELOPMENTS IN AGRICULTURAL SCIENCE.[1]

IN dealing with the science applied to a particular industry like agriculture it is convenient to draw a distinction between the class of investigations which seem to be contributions to knowledge pure and simple and those which aim at an immediate bearing upon practice. Both must be regarded as equally 'pure' science, since both should call for the same qualities of imagination and exact reasoning which characterize true scientific work; but while the one may appeal readily to the intelligent practical man, the value of the other can only be appreciated by the expert. The dividing line between these two branches of the subject is never a sharp one; indeed the most abstract and remote investigations are always cutting into the region of practise in a wholly unexpected fashion; but still the distinction I have indicated can be readily felt. To take an example—for the proper interpretation of many questions connected with the texture of soils and their behavior under cultivation—it is necessary to arrive at a clearer understanding than we now possess of the intimate causes which lead the finest particles of material like clay to unite together into floccules, or coagula, under the influence of traces of dissolved salts. Such investigations will touch upon some of the most debatable ground belonging to the theory of solutions and the constitution of matter, and can never be made intelligible to the

[1] Read at the South Africa meeting of the British Association for the Advancement of Science.

practical man himself; yet a knowledge of their results may be indispensable to the expert whom he consults about the character or management of his land, however trivial and workaday the actual question may seem.

In any agricultural experiment station worthy of its name, place should be found for investigations of this latter class; unfortunately many such institutions are under the necessity of showing 'results' which immediately appeal to the practical man and may be taken to justify the expenditure of public money; so that it is only by side issues, as it were, and by degrees, as the general public can be brought to trust its scientific men, that such work will be undertaken.

It is not my purpose, however, to deal to-day with this form of abstract research. I rather propose to point out certain lines of work in agricultural science which are now being pursued with increasing vigor, and which, from the very outset, promise to have considerable applications in practical life.

It is in the domain of agricultural bacteriology that perhaps the greatest progress has been recently made, in the main progress in connection with that perennial problem—the sources of the nitrogen of vegetation. From the very beginnings of agricultural chemistry, which we may very well date from the publication of De Saussure's 'Recherches Chimiques sur la Végétation' in 1804, discussion has raged round this point. Liebig, in his famous report to this association in 1842, regarded the atmosphere as the source of the nitrogen contained in the plant; but in the long controversy that followed, the view finally prevailed that the plant was only able to utilize already combined nitrogen in the soil, so conclusive seemed the experiments conducted by Boussingault and by Lawes, Gilbert, and Pugh at Rothamsted. But a fresh turn was given to the whole question by the discovery made by Hellriegel and Wilfarth in 1887 that the leguminous plants in virtue of the bacteria living symbiotically in the nodules on their roots were able to fix atmospheric nitrogen. From that time research has been directed towards the problem of utilizing and rendering more effective this particular *Bacterium radicicola.* Widely distributed as it is in the soil, it is yet not universally present; heaths and peaty soils, for example, that have never been under cultivation frequently lack it entirely; consequently, it is impossible to obtain a satisfactory growth of leguminous crops, upon which in many cases the possibility of successful reclamation is based, until this class of land has been inoculated with the appropriate organism.

Again, although but one species of bacterium seems to exist, yet several investigators have found that by its continued existence in symbiosis with particular host plants it has acquired a certain amount of racial adaptation, so that, for example, clover will flourish best and assimilate the most nitrogen if it be inoculated with the organism from a previous growth of clover, and not from a pea or a bean plant.

The conclusion naturally follows that it may be necessary to inoculate each leguminous crop with its appropriate organism in order to secure a maximum yield. The first practical efforts in this direction did not, however, meet with much success: the cultivations used for inoculation were weak, and, when sown with the seed, in many cases died before infection took place. Even when the formation of nodules followed, yet the assimilation of nitrogen was not great. The question in fact turns upon the degree of 'virulence' possessed by the subcultures used for inoculation. It is well known with other bacteria how their specific actions may be-

come entirely modified by growing on particular media, or at a high temperature, and even by long-continued growth under laboratory conditions.

B. radicicola does not develop very freely on the ordinary media used for the cultivation of bacteria, nor can it be made to fix much free nitrogen when removed from the host plant. In particular it is maintained that the medium used, gelatine with an infusion of some leguminous plant, causes the organism to lose, to a very large extent, its power of fixing nitrogen, because it contains so much combined nitrogen. G. T. Moore, for instance, says: "As a result of numerous trials, however, it has been found that although the bacteria increase most rapidly upon a medium rich in nitrogen, the resulting growth is usually of very much reduced virulence; and when put into the soil these organisms have lost the ability to break up into the minute forms necessary to penetrate the root-hairs. They likewise lose the power of fixing atmospheric nitrogen, which is a property of the nodule-forming bacteria under certain conditions." Latterly the subcultures have been made on media practically free from nitrogen, on agar agar, for example, or on purely inorganic media, supplied, of course, with the carbohydrate, by the combustion of which is to be derived the energy necessary to bring the nitrogen into combination.

In example of the two preparations now being distributed on a commercial scale, the one sent out by Professor Hiltner, of the Bavarian Agricultur-botanische Anstalt, consists of tubes of agar which have to be rubbed up in a nutrient solution containing glucose, a little peptone, and various salts, and this after growth has begun is distributed over the soil or the seeds just before sowing. Moore, of the U. S. Department of Agriculture, finding that the bacterium will resist drying, dips strands of cotton-wool into an active culture medium and then dries them. The cotton-wool is then introduced into a solution containing maltose, potassium phosphate and magnesium sulphate; in a day or two growth becomes active, and the solution is distributed over soil or seed.

It is too early yet to determine what measure of success has been attained by these inoculations with pure cultures; but in considering the results a sharp distinction must be drawn between their use on old cultivated and, such as we are dealing with in the United Kingdom, and under the conditions which prevail in new countries where the land is often being brought under leguminous crop for the first time. Few of our English fields have not carried a long succession of crops of clover, beans, vetches and kindred plants; the *Bacterium radicicola* is abundant in the soil; and, however new the leguminous plant that is introduced, infection takes place unfailingly, and nodules appear. It is true that the organism causing nodulation may not belong to the particular racial adaptation most suited to the host plant, and that in consequence an inoculation from a suitable pure culture might prove more effective. Again, it is possible that even a plant like clover, which would be infected at once through the previous growth of the crop, might be made a greater collector of nitrogen through the introduction of a race of bacteria which had acquired an increased virulence; but in either of these cases the most that could be expected from the inoculation would be a gain of 10 per cent. or so in the crop. This great, though limited, measure of success depends upon two things—on obtaining races of *B. radicicola* possessing greater virulence and greater nitrogen-fixing power than the normal race present in the soil, and again on the possibility of establishing this race upon the leguminous crop under ordinary

field conditions, when the introduced organisms are subject to the competition both of kindred bacteria and of the enormous bacterial flora of any soil. Up to the present all evidence of greater nodule-forming power and increased virulence of the artificial cultures has been derived from experiments made under laboratory conditions without the concurrence of the mass of soil organisms.

In the other case, however, where new land is being brought under cultivation and leguminous crops are being grown for the first time, there can be no doubt of the great value of inoculation with these pure cultures of the nitrogen-fixing organism. An example is afforded in Egypt, where land that is 'salted,' alkali or 'brak' soil, is being reclaimed by washing out the salt; inoculation may be necessary before a leguminous crop can be started on such new land, though in many cases the Nile water used for irrigation is quite capable of effecting inoculation. The body of evidence brought together by the United States Department of Agriculture is very convincing, and shows in repeated examples that the use of Moore's cultures has enabled farmers to obtain a growth of lucerne and kindred plants, which before had been impossible. In view of the economic importance the lucerne or alfalfa crop is assuming in all semiarid climates, the financial benefit to the farming community is likely to be great and immediate. And since in the development of South African farming the lucerne crop is likely to become very prominent, both as the most trustworthy of all the fodder crops and as the one which brings about the maximum enrichment of the soil by its growth, the behavior of the lucerne plant as regards bacterial infection in South African soils is worthy of most careful investigation. It is necessary to know to what extent nodules are formed when lucerne is planted on new soils in South Africa, as, for example, on freshly broken-up veldt; the condition of the organisms within the nodule should be investigated, so as to ascertain if improvement be possible by inoculation from pure cultures, either imported or prepared *de novo* from lucerne within the country. These and kindred questions connected with the symbiosis of the nitrogen-fixing organism and the leguminous plants must to a large extent be worked out afresh in each country, and South Africa, with its special conditions of soil and climate, can not take on trust the results arrived at in Europe or America.

I have spoken of the enrichment of the soil due to growing lucerne, caused by the decay of the great root residues containing nitrogen derived from the atmosphere; an enrichment which is quite independent of the amount of similarly combined nitrogen taken away in the successive crops of leafy growth. Some of the Rothamsted experiments show very clearly how great the gain may be. In the first place I will call your attention to the effect of a crop of red clover grown in rotation upon the crops which succeeded it, since in the Agdell rotation-field we get a comparison between plots growing red clover once every four years and other plots on which a bare fallow is substituted for the clover.

The table shows that in one particular case, when an extra large crop of clover was grown, notwithstanding the fact that the clover plots yielded between three and four tons per acre of clover hay, yet the wheat crop which followed this growth of clover was 15 per cent. better than the wheat crop following the bare fallow. The swede turnip crop, which followed the wheat, although similarly and heavily manured on both plots, continued to be better where the clover had been grown two years previously; and even the barley,

TABLE I.

Manuring for Swede Crop Only.	Clover, 1894.	Wheat, 1895.			Roots, 1896.			Barley, 1897.		
		After Fallow.	After Clover.	Increase Due to Clover.	After Fallow.	After Clover.	Increase Due to Clover.	After Fallow.	After Clover.	Increase Due to Clover.
	Cwt.	lb.	lb.	Per Cent.	Cwt.	Cwt.	Per Cent.	lb.	lb.	Per Cent.
Mineral Manure...	59.7	4,220	5,180	+22.7	179.1	244.5	+36.5	2,103	3,991	+89.8
Complete Manure..	76.7	4,547	5,209	+14.6	379.8	388.8	+ 2.4	3,595	4,913	+36.7

which came next, three years after the clover, showed a decided superiority on the clover land. Thus a clover crop, itself wholly removed from the land, exercised a marked influence for good on at least the three succeeding crops grown under the ordinary conditions of farming. Next we can make a comparison between red clover and lucerne. On some of the Rothamsted plots various leguminous plants have been grown for many years, with indifferent success indeed, because of the well-known reluctance of the land to support such crops except at intervals of four or more years. Eventually the plots on which these indifferent crops had been secured were ploughed up and sown with wheat without any manure. In five years the wheat was thus grown on the residues left in the soil by the previous leguminous crops, and from the table will be seen the comparative value of these residues in the case of lucerne and red clover.

TABLE II.

Harvest.	Grain.		Total Produce.	
	After Lucerne.	After Red Clover.	After Lucerne.	After Red Clover.
	Bushels.	Bushels.	Pounds.	Pounds.
1899	39.3	43.0	8,108	8,505
1900	28.9	19.1	4,554	2,992
1901	27.0	21.4	4,054	3,185
1902	20.1	17.7	3,553	3,023
1903	19.9	16.7	3,035	2,528
Total.	135.2	117.9	23,304	20,223

As we have previously seen how great the benefit of a single year's growth of red clover may be on the succeeding crops, an idea can be formed from the comparison in the latter table of how much more lucerne may contribute towards building up a fertile soil; a point which was very markedly brought out in the experiments of the late Mr. James Mason.

The question of the fixation of atmospheric nitrogen by bacterial agencies does not, however, end with the organisms living symbiotically on the leguminous plants, for several other organisms have latterly been discovered which possess the power of fixing nitrogen independently, provided they are supplied with the necessary nutriment. Of late attention has been chiefly directed to a conspicuous organism known as *Azotobacter chroococcum*, which may be readily identified in most cultivated soils. The impure cultures (which may be quickly obtained by introducing a trace of soil into a medium containing no nitrogen, but a little phosphate and other nutrient salts, together with one or two per cent. of mannite or other carbohydrate) fix nitrogen with considerable activity; in one case, for example, when working with a Rothamsted soil, as much as 19 mg. of nitrogen were fixed for each gram of mannite employed and partially oxidized. But Beyerinck, the discoverer of the organism, now attributes the nitrogen fixation to certain other organisms which live practically in symbiosis with the *Azotobacter*, and which are present in the impure cultures just referred to. The exact source of the nitrogen fixation may be left a little doubtful; still the main fact remains that from the bacteria present in many soils one or a group may be found capable of effecting

rapid and considerable nitrogen fixation if the necessary conditions, chiefly those of carbohydrate supply, are satisfied.

But how is the carbohydrate supply to be obtained? Under the normal conditions of arable land farming there are few possibilities in this direction, the occasional ploughing under of a green crop being the only considerable addition of organic matter other than manure, which is possible in practise. As a matter of experience the plots at Rothamsted, which have been growing crops without manure continuously for the last fifty years, indicate but little gain of nitrogen from the atmosphere. After a rapid fall in production for the first few years, the yield has become so nearly stationary that any further decline is not as yet discernible amid the fluctuations due to season.

TABLE III.

Average Amounts of Dry Matter and Nitrogen in Total Produce of Various Crops, grown without Manure at Rothamsted.

	Dry Matter.						Nitrogen.
	Averages Over.					Whole Period.	Whole Period.
	10 Years, 1852-1861.	10 Years, 1862-1871.	10 Years, 1872-1881.	10 Years, 1882-1891.	10 Years, 1892-1901.		
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Broadbalk Wheat.	2,199	1,791	1,346	1,480	1,514	1,666	17.0
Hoos Barley	2,352	1,797	1,303	1,229	1,120	1,560	15.3
Agdell Rotation[2]	2,321	1,817	1,403	1,644	1,295	1,696	17.6
Park Hay[3]		2,082	2,144	2,196	1,421	1,961	33.8

Table III. shows the average yield during the last five decades of dry matter and of nitrogen from four of the unmanured plots at Rothamsted; it will be seen that the difference in the production during the last as compared with the second period of ten years is no more than would be covered by seasonal variations. In other words, the yield, which, as we learn in other ways, is mainly determined by the amount of available nitrogen, has reached a state of equilibrium when the resources of the soil, the material brought down by the rain, and the nitrogen-fixing agencies taken together are just equal to providing the crop with about 17 lbs. of nitrogen per acre per annum in addition to the unknown amounts removed by drainage and in the weeds. The small amount of fixation this indicates and the corresponding low level of production must be set down to the lack of combustible carbohydrate, due to the very complete removal of the various crops from the soil, since the root and stubble left behind after the growth of a cereal crop amount to but a small fraction of the total produce.

In the case of grass-land the conditions are entirely different, especially when we are dealing with wild prairie or forest, where the annual growth of carbohydrate falls back to the soil and is available for such organisms as the *Azotobacter*. At Rothamsted two plots of land which were under arable cultivation twenty-five years ago have been allowed to run wild and acquire a natural vegetation of grasses and weeds, subject to no disturbance beyond the occasional eradication of scrub and bushes. Samples of the soil taken when the land was still under the plough have been preserved, and the comparison of these with new samples drawn during the last year shows enormous accumulations of nitrogen, even when every allowance has been made for certain inevitable errors in

[2] Carted fallow portion.

[3] First and second crops.

sampling the soil (see Table IV.). Of these two fields the Geescroft plots are the more interesting, for though showing the gain of nitrogen is less (45 lbs. per acre per annum against 98 lbs. on Broadbalk), yet continued observation of the herbage that has sprung upon this field has shown the absence of any leguminous plants. According to a botanical analysis made in 1903 the leguminous plants only constituted 0.4 per cent. of the vegetation (as weighed in the dry state) on the Geescroft 'wilderness,' whereas the corresponding plot on Broadbalk contained 25 per cent. Now, with no leguminous plants to act as collectors of nitrogen the considerable gains of combined nitrogen on this Geescroft land must be set down to the work of *Azotobacter* or kindred organisms which get their necessary supply of carbohydrate from the annual fall of the grassy vegetation.

TABLE IV.

Accumulation of Carbon and Nitrogen in Soil of Land allowed to run wild for more than Twenty Years.

		Per Cent. in Dry Soil.			
		Carbon.		Nitrogen	
		1881-3[4]	1904	1881-3[4]	1904
Broadbalk	1st 9 inches..	1.143	1.233	0 1082	0.1450
	2d "	0.624	0.703	0.0701	0.0955
	3d "	0.461	0.551	0.0581	0.0839
Geescroft	1st 9 inches.	1.111	1.494	0.1081	0.1310
	2d "	0.600	0.627	0.0739	0.0829
	3d "	0.447	0.435	0.0597	0.0652

	Broadbalk.		Geescroft.	
	1881	1904	1883	1904
Nitrogen—lbs. per acre..	5,910	8,110	6,043	6,978
Nitrogen—Increase per acre, per annum, lbs..	—	97.8	—	44.5
Ratio of Carbon to Nitrogen....................	9.4	7.7	8.9	9.2
Ratio of Carbon to Nitrogen in Increase......	—	2.9	—	10.7

The fixation of nitrogen must be an oxidizing process, for no other natural reaction is likely to provide the energy necessary to bring the nitrogen into combination. This being so, some light is thrown on the process in nature by an examination of the ratio of carbon to nitrogen in the accumulations referred to above. At starting, the ratio of carbon to nitrogen in the organic matter of the two soils was much the same—a little less than 10 to 1—but the increase of carbon and nitrogen in the Broadbalk field, *i. e.*, the organic matter which has accumulated in the interim, shows a ratio of only 3 to 1, while the corresponding accumulations in Geescroft field show a ratio not far removed from the original of about 11 to 1. In other words, where there has been the greater accumulation of nitrogen on the Broadbalk field, there has been the greater combustion of carbohydrate, so that the accumulation of carbon is actually as well as relatively smaller. Bacteriological tests seem to show a much greater development of *Azotobacter* with increased powers of fixation in the soil from the Broadbalk than from the Geescroft wilderness; a fact to be correlated with the presence of a fair proportion of carbonate of lime in Broadbalk, but not in Geescroft field.

Another example may be drawn from the experiments carried on by the late Mr. James Mason at Eynsham Hall, Oxon. He had large cemented tanks filled with burnt clay mixed with appropriate quantities of calcium carbonate and phosphate and other nutrient salts, but containing no nitrogen. One of these tanks, after inoculation with a trace of ordinary soil, was sown with a mixture of grass-seeds and has carried a weak but purely grassy vegetation ever since. According to a recent analysis the soil of this tank has in fifteen years accumulated 0.029 per cent. of nitrogen in the surface soil and 0.117 per cent. in the second layer—equivalent to about 870 and 350 lbs. per acre per annum,

[4] Broadbalk, 1881; Geescroft, 1883.

the ratio of carbon to nitrogen in the accumulation being about 18 to 1 and 12 to 1, respectively.

Henry has also shown that the shed leaves of many forest trees during their decay may bring about the fixation of nitrogen; and this fact, which again depends on the oxidation of the carbohydrates of the leaf to supply the necessary energy, has been confirmed in the Rothamsted Laboratory, as well as the presence of *Azotobacter* on the decaying leaf.

It is obvious that one of the most interesting fields for the study of these organisms must lie in the virgin lands of a country like South Africa. We all know that virgin soil may, on the one hand, represent land of almost perpetual fertility; on the other, it may constitute wastes of any degree of sterility. What are the conditions under which ensues that accumulation of humus whose nitrogen will become available under cultivation, the 'black soils' famous in every continent? The ecological botanists are working out some of the great climatic conditions, the amount and distribution of rainfall and temperature which are associated with 'steppe' areas of great accumulated fertility, but the bacterial flora which is fundamentally bound up with the problem remains as yet unexplored.

It is possible also that on some of the newer lands this and kindred bacteria are absent because the conditions are not entirely suitable to their development. A. Koch has shown that the presence of calcium carbonate is necessary to the action of *Azotobacter*, and determinations of the power of soils from the various Rothamsted fields to induce fixation confirm his results, the development of the organism in question being feeble when the soil was derived from some of the fields that had escaped the 'chalking' process to which the calcium carbonate of the Rothamsted soils is due.

The value of calcium carbonate in this connection only adds to the many actions which are brought about by the presence of lime in the soil—lime, that is, in the form of calcium carbonate, which will behave as a base towards the acids produced by bacterial activity. The experimental fields at Rothamsted afford a singular opportunity of studying the action of lime, since the soil, a stiff, flinty loam, almost a clay, is naturally devoid of calcium carbonate, though most of the cultivated fields contain now from 2 to 5 per cent. in the surface soil, due to the repeated applications of chalk, which used to be so integral a part of farming practise up to the middle of the nineteenth century. Where this chalking process has been omitted, as is the case in one or two fields, the whole agricultural character of the field is changed: the soil works so heavily that it is difficult to keep the land under the plough; and as grass land it carries a very different and altogether inferior class of vegetation. On the experimental fields it has been possible to measure the rate at which natural agencies, chiefly the carbonic acid and water in the soil, are removing the calcium carbonate that has been introduced into the surface soil, and it is found to be disappearing from the unmanured plots under arable cultivation at an approximate rate of 1,000 lbs. per acre per annum; a rate which is increased by the use of manures like sulphate of ammonia, but diminished by the use of nitrate of soda and of dung. Failing the renewal of the custom of chalking or liming—and its disuse is now very general—the continuous removal of calcium carbonate thus indicated must eventually result in the deterioration of the land to the level of that which has never been chalked at all, and even a state of sterility will ensue if much

use is made of acid artificial manures. That many soils containing naturally only a trace of calcium carbonate remain fairly fertile under ordinary farming conditions is due, on the one hand, to an action of the plant itself, which restores to the soil a large proportion of the bases of the neutral salts upon which it feeds, and partly to the action of certain bacteria in the soil, which ferment organic salts like calcium oxalate existing in plant residues down to the state of carbonate. Were it not for these two agencies restoring bases the soil must naturally lose its neutral reaction, since the process of nitrification is continuously withdrawing some base to combine with the nitric and nitrous acids it sets free.

This varying distribution of calcium carbonate in soils suggests another section of my subject, in which great activity has prevailed of late—the undertaking of a systematic series of soil analyses in any district, with a view to making soil maps that shall be of service to the agriculturist. The Prussian government has long been executing such a soil survey, and during the last few years a similar project has been pushed forward with great energy in the United States; in France and in Belgium several surveys are in progress, but in the United Kingdom the matter has so far only excited one or two local attempts. While the basis of such work must always be the geological survey of the district, a geological survey in which, however, the thin 'drift' formations are of greater importance than the solid geology, there are certain other items of information required by the farmer which would have to be supplied by the agricultural specialist. In the first place, the farmer wants to be told the thickness of the superficial deposits; he requires frequent 'ground profiles,' so that he can construct an imaginary section through the upper 10 feet or so of his ground. To take a concrete example: the chalk in the south of England is very often overlaid by deposits of loam, approaching the nature of brick earth, and the agricultural character of the land, its suitability for some of the special crops, like hops and fruit, which characterize that district, will be wholly different according as the deposit is 3 feet or 10 feet deep. The proximity and, if near the surface, the direction of flow of the ground water are also matters on which there could be given to the farmer information of great importance when questions of drainage or water-supply have to be considered. It is necessary also to refine upon the rough classification of the soil and subsoil which alone is possible to the field surveyor, one of whose functions will be to procure typical samples of which the texture and physical structure can afterwards be worked out in the laboratory. Geological formations are constantly showing lithological changes as one passes along their outcrop either in a vertical sense or in their lateral extension; and these changes are often reflected by corresponding changes in the character of the soil which are of commercial importance.

But while the mechanical analysis of the soil has been of late the basis upon which all soil surveys are constructed, it is of equal importance, at any rate in the older countries under intensive cultivation, to undertake certain chemical determinations, which come to possess a new value when taken in connection with a soil survey. It has been generally demonstrated that an analysis, physical and chemical alike, of the soil of a particular field, taken by itself, possesses but little value. The physical analysis will indicate roughly the character of the soil, but very little better than could have been learned by walking over the soil and digging in it for five minutes; the chemical analysis will disclose any glaring deficiencies; but, as a rule, the analytical

figures will be of a very indecisive character, and will lead to little information of practical value. This is because the productivity of a given piece of land depends upon a large number of agencies, any one of which may be the limiting factor in the crop yield. We may enumerate, for example, temperature and water-supply, both determined by the climate, by the natural physical structure of the soil and by the modifications in its texture induced by cultivation; there are further the aeration and the actual texture of the soil, the initial supply of plant-food of various kinds and, again, the rate at which this last item is rendered available to the plant by bacterial action or by purely physical agencies. All these factors interact upon one another. To all of them and not merely to the nutrient constituents does Liebig's law of the minimum apply; so that any one may become the limiting factor and alone determine the yield. It is of no use, for example, to increase the phosphoric-acid content of a soil, however deficient it may be, if the maximum crop is being grown that is consistent with the water-supply, or if the growth of the plant is being limited by insufficient root range caused by bad texture and the lack of aeration in the soil. However much we may refine our methods of analysis, we may take it as certain that we shall never be able to deduce *à priori* the productivity of the soil from a consideration of the data supplied by the analysis. The function, then, of soil analysis is not to make absolute deductions from the results, but by a comparison of the unknown soil under examination with other soils already known to interpret the divergences and similarities in the light of previous experience. That a given soil contains one tenth per cent. of phosphoric acid or one fiftieth per cent. of the same constituent soluble in a dilute citric-acid solution is in itself meaningless information; but it becomes of great value when we know that the normal soils of that particular type contain less than this proportion of phosphoric acid as a rule, and yet show no particular response to phosphatic manuring.

What, then, the soil analyst can do is to characterize the type, ascertain its normal structure and composition, and correlate its behavior under cultivation, its suitability for particular crops and its response to manuring in various directions. Thus an unknown soil may by analysis be allotted to its known type, deviations from the type can be recognized and conclusions may be drawn as to the connection of these defects.

Valuable as recent development of soil analysis may have been (and I allude in particular to the improvements in the methods of mechanical analysis which have been worked out in the United States Department of Agriculture, to the many investigations that have been made on the measurement of 'available' plant-food by attack with weak acid solvents, to the determinations of the bacterial activity of the soil), the results they yield can only be truly interpreted when they can be compared with a mass of data accumulated by the use of the same methods on known soils.

One of the services, then, which the farmers in every country may very properly expect from the scientific man is such a survey of the principal soil types, affording the necessary datum lines by which the comparative richness and poverty of any particular soil may be gauged. In an old settled country like the United Kingdom such a survey would guide the farmer in his selection of manures; in a new country the advantages would be even more apparent, as the areas appropriate to particular crops would be indicated, and settlers would be saved from many expensive attempts to introduce things for which their land was unsuited.

It would also be possible to indicate the

measures which should be taken to ameliorate the nature of the poorer soils, for, remote as may now seem the prospects of spending time and labor on bad land in new countries where there is still a choice of good, once the road to improvement is indicated little by little the work will be done. It is hardly realized to what extent the soils in England have been 'made'; the practise of 'chalking,' previously mentioned as having doubled or trebled the value of the Rothamsted land, must have added between 100 tons and 200 tons of chalk per acre to those soils before the end of the eighteenth century, and in other parts of the country marling, claying, incorporation of burnt earth and other lighter material have contributed enormously to render the present degree of fertility possible.

The main facts of the nutrition of the plant have been so long established that it is not always realized how much still remains unknown. It has become a commonplace of the text-books that the plant needs nitrogen, phosphoric acid, potash, often in excess of the quantities present in a normal soil; so that these substances alone are considered of manurial value, other necessary materials like lime, magnesia, iron, sulphuric acid and chlorine being practically never lacking under natural conditions. But the function of these substances in the development of particular plants, the manner in which the character of the crop is affected by an excess or a deficit, is still imperfectly apprehended. We realize the dependence of vegetative development upon the supply of nitrogen, and how an excess defers maturity; we are also beginning to gather facts as to the manner in which an overplus of nitrogen causes alterations in the structure of the tissues and variations in composition of the cell contents that result in increased susceptibility to fungoid attack. Again, it is clear that potash takes a fundamental part in the process of assimilation, the production of carbohydrate in all forms being dependent on the supply of potash; but of the manner or the location of the action we have no knowledge. Our ignorance of the function of phosphoric acid is even greater; broadly speaking, it hastens maturity, and is bound up with such final processes in the plant's development as the elaboration of seed. With this we naturally correlate on *à priori* grounds the presence of phosphorus in the nucleo-proteids; but there is no particular evidence that excess of phosphoric acid leads to increased assimilation of nitrogen.

Some of the barley plots at Rothamsted show this very clearly; where there has been no phosphatic, but a nitrogenous, manuring for the last fifty years, the amount of nitrogen assimilated by the crop is diminished, but the gross production of dry matter is still further diminished. By the addition of phosphoric acid the gross production is increased to a greater degree than the amount of proteid formed is increased, so that the crop shows now a smaller percentage of nitrogen and a lower ratio of nitrogen to phosphoric acid than on the plots which are experiencing phosphoric-acid starvation. In other words, where an excess of nitrogen is available the amount assimilated does not increase *pari passu* with the amount of phosphoric acid which the plant can obtain.

But with these three substances all exact knowledge ceases; magnesia, sulphuric acid and chlorine are invariable and necessary constituents of all plants, yet their function and their practical effects are still unknown. To take a further example, it was early in the history of agricultural science that silica was discovered to be the chief constituent of the ash of cereals and of a few other plants. Liebig's term of 'silica plants' still survives to show the importance once attached to this body, and

the earlier experimenters with manures used soluble silicates with the idea of thereby increasing the stiffness of straw. But further investigations showed that cereals could be brought to maturity without any supply of silica, and that the stiffness of the straw was a physiological matter in no way conditioned by silica. As a consequence this plant constituent has now been disregarded for a long time. But it is idle to suppose that a substance present, for example, to the extent of 60 per cent. or so in the ash of the straw of wheat, has no part to play in the nutrition of the plant. Among the Rothamsted experiments there are fortunately some barley plots which have received soluble silica for many years, and a recent examination of the material grown on these plots begins to cast some light on the function of silica. Its effect upon the plant is in some way parallel to that of phosphoric acid; on the plots which have had no phosphatic manure for more than fifty years an addition of soluble silica increases the crop, increases the proportion of grain and hastens the maturity in exactly the same fashion, though to a less degree, than an addition of phosphoric acid. The results point to the plant rather than the soil as being the seat of the action; a plant that is being starved of phosphoric acid can economize and make more use of its restricted portion if a quantity of soluble silica be available. There is no possibility of replacing phosphoric acid by silica in the general nutrition of the plant, but the abundance of silica at the disposal of the cereals certainly enables them to diminish their call for phosphoric acid from the soil.

Much in the same direction lie the researches which are being pursued with so much vigor by Loew and his pupils in Japan on the stimulus to assimilation and plant development which is brought about by infinitesimal traces of many metallic salts not usually recognized as being present in plants at all. It has been often recognized that substances which are toxic to the cell in ordinary dilutions may, when the dilution is pushed to an extreme, reach a point at which their action is reversed and begins to stimulate. Probably some of the materials used as fungicides and inhibitors of disease act in this fashion by strengthening the whole constitution of the plant rather than by directly destroying or checking the growth of the fungus mycelium. The subject is certainly one which promises to yield results of value in practise, and calls for more extended and exact observation.

The importance of research on the particular function of the various constituents of the crop lies in the fact that it is only by the possession of such knowledge we may possibly influence in desired directions the quality of our crops. With the effect of manuring upon the yield of most of our crops we are now familiar, but the question of 'quality,' almost as important as that of yield, forms a more difficult problem. One particular example may be cited, that of wheat, because of late years it has been a subject of investigation in most wheat-producing countries. That quality of wheat which is of special commercial importance is its so-called 'strength,' the capacity of yielding flour of such a consistency in the state of dough as will retain the gases produced in fermentation with the formation of a tall, well-piled loaf. This property of 'strength' is usually found in a hard horny and translucent grain, the soft, mealy-looking wheats being as a rule 'weak.' Again, the strong wheats usually originate from districts like the Hungarian plain, the Northwest of America, and south Russia, countries characterized by a typical continental climate, cold and dry in the winter, with rains in the late spring and early summer, and a gradually increasing dry-

ness and temperature up to the time of harvest. The wheats grown under the opposite conditions of a winter rainfall and a dry summer, as on the Pacific slope of North America, or an evenly distributed rainfall as in England or France, are on the whole weak. The differences in this quality are considerable when measured commercially; for example, in most seasons the best Manitoban wheat will be worth 20 to 25 per cent. more than a corresponding grade of English wheat on the London market. The source of strength lies among the nitrogenous constituents of the wheat flour; it can be measured roughly either by determining the proportion of nitrogen in the flour, or by the old process of washing away the starch and leaving the gluten. Neither process agrees exactly with baking tests, nor do any of the more recent attemps to differentiate the wheat proteids by their solubility in various media, as, for example, the determination of the so-called *gliadin glutenin ratio*. In fact, in the present state of our knowledge of the possibilities of identifying and separating the proteids in a pure state, there is little likelihood of being able to make out the subtle differences of chemical composition which result in the varying quality of the wheat proteid mass. For example, the relative strength of different varieties of wheat grown under similar conditions will follow the order in which the wheats are placed by their content in nitrogen; yet if, as at Rothamsted, an increased nitrogen content in the wheat is brought about by excessive nitrogenous manuring, the product is actually considerably weaker than wheat on the other plots grown under more normal conditions. The manuring, while increasing the nitrogenous matter of the wheat, has probably introduced a new factor in the shape of a more prolonged development resulting in the lack of those final changes in the nature of the wheat proteids which make for strength. This seems to be indicated by the fact that on storage this particular abnormal wheat gradually increases in strength up to the normal, though never to the degree that would be indicated by its nitrogen content. But though the chemical methods of estimating the strength of wheat have as yet proved inconclusive, some idea of the factors determining this quality has been reached from practical baking tests combined with measurements of the gluten and nitrogen content of the flour. In the first place manuring proves a very small factor; the composition of the grain of wheat is extraordinarily stable and the plant reacts to diversities in nutrition by producing more or less grain rather than by altering its composition. Even under the exceptionally pronounced variations in the manurial conditions of the Rothamsted plots, the composition of the grain fluctuates more with changing seasons than with changed manuring. Within the limits of healthy growth and ripening the date of sowing the wheat has no effect upon the quality of the grain; the same wheat sown at monthly intervals from October to March gave practically identical quality in the grain, and a number of comparisons between autumn and spring sowing led to no definite conclusion. Soil has also a comparatively small effect, though, of course, different soils, by inducing differences in the supply of water to the plants and in the temperature, practically result in differences of climate. The effect of climate is large, whether tested by growing the same variety in different countries or by inducing artificial variations in the climate of wheats grown under experimental conditions. But while the climatic factor proves to be large it is less than was anticipated; an English soft wheat, for example, grown on the Hungarian plain for two seasons, has not altered greatly in character nor taken on the characteristic ap-

pearances of the wheat of the district. A specially strong wheat from the Canadian Northwest, after some considerable fall of strength in the first English crop, has fallen no further after three successive crops, and still retains all the characters of an exceptionally strong wheat, although the yield remains poor from an English standpoint. Other varieties have rapidly and entirely lost their strength when changed to English conditions from America, or Hungary, or Russia; many, however, while showing the effect of climate, yet stand apart from the typical English wheats and show no tendency to 'acclimatize' in the sense of acquiring the character of the local varieties. In the whole work the thing which stands up most prominently is the fundamental importance of the 'variety'; each race, each botanical unit as it were, possesses an individuality and yields grain of a characteristic composition; and though climate, soil, season, manuring, are factors producing variation in the composition, they are all small compared with the intrinsic nature of the variety itself. Similar conclusions follow from the work of Wood and his colleagues upon the composition of mangels, and of Collins on the composition of swedes. The proportion of dry matter and sugar in the root, while varying markedly in the individual roots, possesses a typical value for each race; and though season, locality and to some extent manuring affect the composition, the changes thus induced are not great.

Starting, then, from this point, that variety or race is the chief factor in the composition of a given plant, and that, once the variety is fixed, the other factors, which are more or less under control, such as manuring, soil and climate, have but minor effects upon the quality, the road to the improvement of the quality of our farm crops lies in the creation of new varieties by breeding. An improved variety is all clear gain to the farmer; climate, season and to a large extent soil are outside his control; while better manuring and cultivation, however much their cost may be lessened by increased skill, yet involve expenditure and become unremunerative above a certain point. But an improved variety, without costing any more to grow, may increase the returns by 10 or 20 per cent., in some cases may nearly double them.

As regards the value of selection, Wood shows that the composition of the mangel, which has been selected solely for such external qualities as shape and habit, has remained stationary during the fifty years or so for which we possess any information; while between 1860 and 1890 the sugar beet has had its sugar content raised from an average of 10.9 to 15 per cent. by the steady selection of seed-mothers for their richness. The prospects of breeding new varieties of wheat, and particuarly of securing improvements in such qualities as 'strength,' have been enormously improved within the last year or two through the investigations which have followed on the rediscovery of Mendel's law of inheritance. Wheat as a normally self-fertilized plant is particularly suited to the investigation of Mendel's law, and the work of Biffen shows that, with a few possible exceptions, the characters of the parent varieties are inherited strictly in accordance with the expectations derived from a consideration of that law. The great practical importance of this generalization lies in the fact that it thus becomes possible to pick out with certainty fixed types in the third generation of the hybrids, whereas without the guidance of Mendel's law and working by the old plan of selection, followed by continuous 'rogueing,' it was impossible ever to secure a pure strain unless by chance an individual possessing

pure recessive or pure dominant characters had been hit upon from the first.

Biffen's work further indicates that the power of producing a glutinous grain, such as will lead to 'strength' in the flour, is a Mendelian character, following the same laws of inheritance as the bearded or beardless habit or the color of the grain or chaff. Extreme strength shown in any particular wheat can then be picked out and combined with any other essential qualities, such as the yield and the character of the straw, which distinguish our present varieties of wheat. Of course the inheritance of a quality like strength, which is only relative between different varieties, can not be traced with the sharpness with which such characters as the long-awned bearded type can be followed; still the variation that is, as it were, superimposed upon the 'strength' or 'weakness' representing the inherited Mendelian character is not sufficient to obliterate the evidence of inheritance according to the law. And, of course this variation of individual seedlings in the 'strong' section above and below the degree of strength possessed by the parent, *i. e.*, the inherited character, gives the plant-breeder his opportunity of improving such a quality at the same time as he is combining with it the other characteristics that are desired in the new varieties. Biffen's work among the wheat hybrids touches also upon another point of special importance to South African farming, where the incidence of 'rust' forms the greatest obstacle of extensive and successful wheat-growing. The climatological conditions which make for a rust attack have not been worked out, as far as can be judged from the behavior of English wheats in various seasons, together with the prevailing climates in countries where rust is specially prevalent; a flush of growth in the spring followed by high temperatures will favor the disease, but South Africa, with its great variations in the amount and incidence of the rainfall and with its very different temperatures, affords a very good opportunity for obtaining information on this point. Returning, however, to the question of variety, it is generally recognized that relative immunity or susceptibility to an attack of yellow rust is characteristic of particular varieties, and Biffen finds that such 'immunity' is a true Mendelian character, recessive and therefore only appearing in the second generation of hybrids between a rusting and rust-proof parent. It is not correlated with shape or character of the leaf, but is transmitted from one generation to another quite independently, and can, therefore, be picked out of a desirable parent and combined with other qualities of value in different parents. Here, again, we are dealing with a character that is only relative, for no wheat can be called either absolutely rust-proof or entirely susceptible; the offspring that have inherited immunity will still vary a trifle among themselves in the degree of their resistance to attack, and in this possibility of variation lies the chance of the plant-breeder to improve upon the rust-resisting powers of the varieties we now possess.

The whole work of the plant-breeder is of singular importance in a country like South Africa whose agricultural history is so recent. Our European crops represent the culminating points of a tradition, and are the fruit of the observation and judgment of many generations of practical men working, as a rule, with chance material. The products are eminently suited to European conditions, but, as has been seen so often, they fail comparatively when brought into other climates and soils. It follows, then, that in a new country the work of the acclimatizer is one of the necessary foundations for agriculture, and this involves a careful study of climatology

and of the influence that the distribution of rainfall and temperature in various parts of the country has on the character of the crop.

Then the cross-breeder's work begins: acclimatization alone is hardly likely to yield the ideal plant, but by it are found plants possessing the features, one here and one there, that are desiderated; and starting with this ground material the hybridizer can eventually turn out an individual possessing to a large measure all the qualities that are sought for.

There is little hope that science can do anything wholly new for agriculture; acclimatization, breeding and selection have been the mainstay of farming progress since the beginning of time, just as the action of the nitrifying bacteria and of nitrogen fixation by the leguminous plants was instinctively apprehended by the earliest farmers of whom we have any record.

But with increasing knowledge comes more power, and particularly the possibility of accelerating the rate of progress; agricultural improvements in the past have resulted from the gradual and unorganized accretions of the observation and experience of many men, often of many generations, now that we are provided by science with guiding hypotheses and by the organization of experiment with the means of replacing casual opinions by exact knowledge. Even the properties of the soil and the character of our farm crops and animals—stubborn facts as they are and deeply grounded in the nature of things—ought to become increasingly plastic in our hands.

A. D. HALL.

SCIENTIFIC BOOKS.

Physiological Economy in Nutrition. By RUSSELL H. CHITTENDEN, Ph.D., LL.D., Sc.D. New York, F. A. Stokes Co. 1904.

This notable volume, the production of Professor Chittenden and his coworkers, of whom Professor Lafayette B. Mendel is the most prominent, finally dispels the tradition that a continued liberal allowance of proteid in a normal diet is a prerequisite for the maintenance of bodily vigor.

Professor Chittenden had suffered from persistent rheumatism of the knee joint and determined on a course of dieting which should largely reduce the proteid and calorific intake. The rheumatism disappeared and minor troubles such as 'sick-headaches' and bilious attacks no longer recurred periodically as before.

> There was a greater appreciation of such food as was eaten: a keener appetite, and more acute taste seemed to be developed and a more thorough liking for simple foods.

During the first eight months of the dieting there was a loss of body weight equal to eight kilograms. Thereafter for nine months the body weight remained stationary.

> Two months of the time were spent at an inland fishing resort, and during a part of this time a guide was dispensed with and the boat rowed by the writer frequently six to ten miles in a forenoon, sometimes against head winds (without breakfast) and with much greater freedom from fatigue and muscular soreness than in previous years on a fuller dietary.

During this latter period of nine months the nitrogen of the urine was determined daily. The average was 5.69 grams. During the last two months this was reduced to 5.40 grams. Experiments showed that about one gram of nitrogen was eliminated in the fæces, and that nitrogen equilibrium could be maintained with dietaries of low calorific value (1,613 and 1,549 calories) containing 6.40 and 5.86 grams of nitrogen. These figures correspond to diets containing 40 and 36.6 grams of proteid instead of 118 grams commended by Voit and honored by habit and tradition. The foods with the strongest flavors are meats.

Professor Chittenden believes that the large quantity of proteid in the ordinary diet is due to self-indulgence. He protests against such indulgence and believes that a futile strain is thereby placed upon the liver, kidneys and other organs concerned in the transformation and elimination of the end products of proteid metabolism.

These experiments, however, were not confined to an individual or even to a single group of individuals. Similar experiments were made on other professional men, on student athletes in training, and on soldiers under military regimen. The nitrogen in the urine was determined daily in twenty-six individuals for periods extending from five to nine months.

Summarizing the results obtained in all these groups of individuals, it is established that a diet containing about fifty grams of proteid (8 grams of nitrogen) is able to maintain the adult body machine in perfect repair.

The professional group alleged a greater keenness for its work, the athletic group won championships in games, and the soldiers maintained perfect health and strength, many professing repugnance to meat when allowed it after five months of practical abstinence.

Although it is possible that the alleged improved mental condition may have been due to mental suggestion, still the fact remains that it has been absolutely proven by Chittenden's work that the allowance of proteid necessary for continued health and strength may be reduced for many months to one half or less what the habit of appetite suggests.

The reviewer would, however, remark that it still remains to be proven that the fifty grams of proteid in the diet—which is not greater than the body would metabolize in starvation—is advisable as a program for the whole of one's adult life. It may also be that more than this quantity is indicated, during convalescence from wasting disease, or during the muscular hypertrophy which accompanies preliminary training for muscular effort.

The reviewer believes that Professor Chittenden has fallen into error in the commendation of 2,500 to 2,600 calories as an ample energy content for the diet of a soldier at drill. Accurate information on this point is only obtainable through respiration experiments. Chittenden, pursuing a sedentary life, prescribes 2,000 calories for himself or 35 calories per kilogram of body weight, while Mendel requires 2,448 calories or 35.3 calories per kilogram. These are entirely normal values for people at light work. In the earliest calculations of Voit in 1866 it was shown that a man of 70 kilograms on a medium mixed diet produced 2,400 calories, or 34.3 calories per kilogram. Rubner allows 2,445 calories to men of 70 kilograms weight engaged in occupations involving light muscular work, men such as writers, draughtsmen, tailors, physicians, etc.

But the soldiers under Chittenden exercised for two hours in the gymnasium, then apparently drilled for one hour, and walked for another hour. This physical work can only be accomplished at the expense of increased metabolism. Zuntz has shown that to walk 2.7 miles in one hour along a level road requires an extra metabolism equivalent to the liberation of 159.2 calories in a well-trained man weighing 70 kilograms. If a soldier during four hours of exercise actually accomplished the equivalent of work of a walk of ten miles over and above what Professor Mendel accomplished in his laboratory, then the metabolism of the soldier would be larger than Professor Mendel's by 637 calories (159.2×4) or he would have had a total metabolism of 3,085 calories ($2{,}448 + 637$). This does not seem an improbable amount.

For ordinary laborers working eight to ten hours a day, such as mechanics, porters, joiners, soldiers in garrison and farmers, 3,000 calories, as advocated by Voit, is apparently not too great. Rubner's diet for the same class calls for 2,868 calories. Chittenden's allowance of 2,500–2,600 seems to the writer too small, while Atwater's of 3,400 appears excessive.

Unstinted praise for painstaking endeavor and unremitting toil belongs to the workers who have achieved this volume. It is a monument of fidelity and an inspiration to thoroughness in scientific work.

Graham Lusk.
University and Bellevue Hospital Medical College.

The Insulation of Electric Machines. Turner and Hobart. Pp. vi + 297. 146 illustrations. New York, The Macmillan Company. 1905. Price, $4.50.

It is a difficult and tedious task to write a

book upon a subject which is in the empirical stage of its history, yet in this volume the authors have succeeded in producing a work which is rich in useful information, and which the electric constructor will find a valuable addition to his library. From a scientific standpoint perhaps the most interesting portion of the book is the second chapter, which summarizes very effectively the present state of knowledge regarding the dielectric strength of various materials under various conditions. Nothing is more convincing evidence of the need of further investigating the passage of electricity through gases than the discordant values obtained by different experimenters for the dielectric strength of air.

The constructor will find the chapters on field and on armature insulation and on the 'space factor' exceedingly practical and suggestive, and indeed wherever the authors have had the opportunity of drawing upon their own valuable experience and exercising untrammeled their nice discrimination the results are very satisfactory. Unhappily, insulation at present must rank as crude art rather than as science, and art, too, somewhat luridly colored by commercial daubers.

Of patented insulating preparations and secret compounds the name is legion, and good, bad and indifferent, all alike make the most extravagant claims, and back them up by experiments. These compounds can not be left without mention in a book on insulation, for some of them are highly meritorious, but proper and adequate treatment of them is a practical impossibility. In dealing with this part of their subject therefore, the authors can hardly do more than supplement the alleged facts by such data as are available and to let the matter go at that. They have at least avoided the error of assuming commercial data to be altogether reliable by giving several points of view on disputed topics. The chapters treating of oil insulation fortunately escape such difficulties, paraffin and other oils being free from patents and trade marks, and these will well repay study.

The facility with which oils, spite of the old saying that oil and water will not mix, take up moisture enough to ruin their insulating properties will surprise the non-technical reader and suggests an interesting and useful field of research.

As a bit of friendly criticism it should be suggested that in the next edition most of the experimental curves given should be remade by the wax process, in the interest of neatness and easy reference. A very useful bibliography of the subject is a valuable feature of the book, and the index is satisfactorily full. Altogether Turner and Hobart have done a commendable piece of work and one that will be widely appreciated.

Louis Bell.

Boston.

Grundriss der Soziologie. By Ludwig Gumplowicz. Second edition, revised and enlarged. Vienna, 1905.

Sociologists in this country will be interested in this new edition of Doctor Gumplowicz's famous work. In the preface he calls attention to the rapid development of sociological study during the last twenty years, in which development he modestly hints that his 'Grundriss' might well assert, Quorum pars magna fui.

The text of the first edition is preserved intact, with slight verbal changes here and there. The chief modifications consist in additions, reference notes and quotations from later works. In book one, for instance, the history of sociology is brought down to date. Special attention is given in this to the views of Ratzenhofer, whose untimely death while homeward bound from the congress at St. Louis, deprived sociology of one of its foremost writers. Ratzenhofer's 'Positive Ethik' is extensively quoted from in book four, pages 330–336. Discussions of 'Methode der Soziologie,' and 'Geschichtsphilosophische Konstruktionen,' complete the list of important additions.

This last discussion should be read in connection with his article in *American Journal of Sociology,* March, 1905, entitled 'An Austrian Appreciation of Lester F. Ward.' Dr. Gumplowicz frankly admits that he is not yet prepared to believe in the possibility of an 'applied sociology,' but, while still holding to

the position he set forth in his first edition, he is prepared to see his argument become old-fashioned (hinfällig), with advance in sociological knowledge.

The author has lost none of his old-time vigor of expression, nor of his opposition to the 'organic theory.' He takes occasion to give this latter some hard blows, even though his conclusion is, "Diese 'Methode' ist ein für allemal abgetan," page 170.

J. Q. Dealey.

Brown University,
September 12, 1905.

DISCUSSION AND CORRESPONDENCE.

BREEDING BENEFICIAL INSECTS.

Harper's Monthly Magazine is a journal of such high standing and is as a rule so clean and so accurate that anything published in its pages, aside from ostensible fiction, is received by a very large reading public as bearing the stamp of absolute accuracy. It, therefore, becomes necessary whenever an inaccurate statement is published in its pages, and particularly when by such a statement a keen injustice is done to an institution or to an individual, to publish in some way and as speedily as possible an emphatic rejoinder and correction. I, therefore, wish to call attention to the article by H. A. Crafts in the October number of *Harper's Magazine,* pages 778 to 782, which bears the title of this present communication. The article refers to the excellent work which has been done in California in the breeding of beneficial insects, and more especially to the admirable quarantine carried on by that state against the possible importation of new insect pests. To these features of the article no exception can be taken, but there is another and important matter which must be corrected.

Mr. Crafts writes:

> Mr. Craw [Alexander Craw, late Horticultural Quarantine Officer of California] advised that search be made in foreign countries for the parasite that would destroy the 'cottony cushion-scale.' At that time the state had enacted no horticultural laws, and there were no public funds available for the prosecution of the search suggested by Mr. Craw. But to remedy this defect private funds were raised, and Professor Albert Koebele, an attaché of the United States Department of Agriculture, was commissioned to make the quest.
>
> Professor Koebele in the course of his travels went to Australia, where he found a grub feeding upon the cottony cushion-scale. He took the grub and developed it to its condition of maturity, and found that it grew into a small beetle known as a 'ladybird.' At the same time the professor made a second discovery, and that was that a secondary parasite was preying upon the 'ladybird.'
>
> Knowing that it would be fatal to the project to send the ladybird and its parasite to California together, he set about propagating a colony of the little beetles in close confinement. He accordingly had glass-houses built over two small orange-trees in an orchard that was infested with the cottony cushion-scale, and beneath these he bred up some strong colonies of the ladybirds and sent them to Mr. Craw.
>
> Upon their arrival in California the process of propagation was continued and a large number of the bugs raised. * * *
>
> The insects thus raised by Mr. Craw were sent out in small colonies all over the state wherever there was an orange or lemon orchard affected by the cottony cushion-scale and turned loose in the trees. The result was the speedy cleaning up of the pest, and it has remained in subjection ever since. And thus the great citrus-fruit industry of California was saved.

In these statements Mr. Crafts has done a great injustice to the United States Department of Agriculture, and to the late C. V. Riley, at that time (1888–90) chief entomologist of the department. The facts briefly are these. Prior to the Australian expedition of Mr. Koebele, Professor Riley was in California. He attended, with Mr. Craw, a large horticultural meeting, and the subject of sending abroad for parasites was broached at this meeting. It is quite possible that Professor Riley got the original idea from Mr. Craw. Here, however, Mr. Craw's connection with the introduction ceases; nor do I think Mr. Craw has ever made any personal claim which would in any further way substantiate the statements made by Mr. Crafts, just quoted. Professor Riley returned to Washington, corresponded with entomologists in Australia,

but was unable to devote funds from his appropriation to send an assistant to Australia, for the reason that congress at that time restricted travel to the limits of the United States. There was an exposition that year in Melbourne, and he, therefore, called upon the late Thomas F. Bayard, at that time secretary of state, and urged that the traveling expenses of an assistant be paid, for this purpose, from the funds set aside for the exhibition by the United States at the Melbourne exposition, and of which the Department of State had control. His request was granted, and Mr. Albert Koebele, an assistant in the Division of Entomology, was sent over, his expenses simply being paid by the Department of State and his salary by the Department of Agriculture. Mr. Koebele secured the ladybirds, and in the meantime another agent of the Department of Agriculture, Mr. D. W. Coquillett, stationed at Los Angeles, Calif., had prepared a gauze tent over an infested orange tree. All of Mr. Koebele's shipments were sent direct to this assistant of the division of entomology, and not to Mr. Craw. It was at the Los Angeles station of the division that the insects were propagated, and from which they were sent, and not until considerably later did Mr. Craw, as an agent of the state board of horticulture, have anything to do with the matter. When he did take it up, however, he prosecuted the work very successfully, and during the remainder of his term of office (he is now in the employ of the territorial government of Hawaii) he did a great and good work with other beneficial insects. Thus it will be seen that the introduction and establishment of the ladybirds were done by Professor Riley's assistants, the expenses of Koebele to Australia being paid by the Deparment of State.

It so happened that one of the United States commissioners to the Melbourne exposition was the late Frank McCoppin, and Mr. McCoppin also recommended that the funds for Mr. Koebele's expenses be paid by the Department of State. Mr. McCoppin always claimed, in his lifetime, the full credit for the whole thing, but the facts are as I have stated, and they are within my immediate knowledge, since at the time I was first assistant to Professor Riley and was intimately acquainted with everything that was going on.

The introduction of this insect was one of Riley's greatest achievements, since it established a principle upon which much good work has since been done in many parts of the world; and it should be stated to his further credit that he was sanguine of success at the start, and that the work was carried through against the predictions of his two oldest assistants, Mr. E. A. Schwarz and myself, both of us having urged against the probability of the establishment in the nearctic life zone of an insect belonging to the Australasian fauna.

To Mr. Craw, therefore, belongs the credit of being, if not the original suggester of the plan, at least one of the first suggesters, and also the credit of having, some time after the introduction and perfect establishment of the insect, had charge of its propagation. To Mr. McCoppin belongs only the credit of having facilitated Mr. Koebele's work by recommending that his expenses be paid from the Melbourne exposition fund. To Riley and the Department of Agriculture belongs the credit of having, by investigations, shown exactly the spot to go for the supposed beneficial insects; for having furnished the man to go to Australia, and having paid his salary; for having induced wholly or partially the secretary of state to consent to the payment of the traveling expenses from the Melbourne exposition fund; for the preparations for the receipt of the beneficial insects at Los Angeles; and for having cared for them and supervised their establishment, propagation and distribution for many months after arrival, thus bringing about the wonderful results which followed.

L. O. Howard.

NOMENCLATURE AT THE INTERNATIONAL BOTANICAL CONGRESS AT VIENNA.

To the Editor of Science: I have read with much interest Dr. Britton's account in your issue for August 18 of the action in regard to nomenclature taken at the recent International Botanical Congress at Vienna. So far so good. The action seems to have been about what was expected by most Amer-

ican botanists. The failure to recognize the basic principle of generic types, and the absurd recommendation to make exceptions from the rules adopted in the case of over 400 generic names, make it morally certain that these rules will not be final and will not settle the vexed question of nomenclature. It also seems morally certain that these rules will not be even temporarily accepted by the majority of American systematic botanists. I have read Dr. Britton's paper carefully in the hope that I could find either in or between the lines some hint of the position that he, as chairman of the American Nomenclature Commission, intends to take with reference to these really extraordinary rules. I confess, however, that his purpose has been well veiled. The question is one of such immediate interest and importance in view of the publication of the new 'Flora of North America' that I venture to ask for an expression of his views in your columns as to what shall be done next. For my own part I am free to express the opinion that any attempt to conform to the Vienna rules would be most unfortunate and would only serve to postpone still farther the much-desired attainment of practical stability in the use of plant names.

Fortunately for those of us who are interested in the lower cryptogams, the congress has saved us from the necessity of breaking its rules. If it had confessed its incapacity in regard to the higher plants as well, the situation would be far simpler.

F. S. Earle.

Santiago de las Vegas, Cuba,
September 7, 1905.

'CLON' VERSUS 'CLONE.'

I recur to this subject merely to correct the misunderstanding under which Professor Eastman labors, as shown in his recent communication to Science (XXII., p. 206). In my note setting forth the reasons for preferring the spelling *clone*, I did not state the chief fact on which the argument was based, inasmuch as I assumed that any one interested in the subject would undoubtedly consult Mr. Webber's article,[1] in which the word was originally published. Let it be clearly understood, therefore, that viewed in the abstract, one spelling is as good as another, and Professor Eastman's reasons for preferring *clon* would be quite cogent if it were not for the fact that Mr. Webber expressly states that the word is to be *pronounced* with the long sound of *o*. This being the case, I think no one will venture to dispute the point I have already made, that by the requirements of English speech it must be written *clone* or treated purely as a transliteration from the Greek and written *clōn* (preferably *klōn*). Every one of the examples adduced by Professor Eastman (eon, pæon, autochthon, halcyon) affords proof of this, as they are all pronounced with a short *o*. It is quite true, as Professor Eastman states, that 'linguistic usage does not require that loan words and derivatives from other languages should always preserve the same vowel quantities.' But it does require that if the vowel quantity is to be definitely indicated in pronunciation, as Mr. Webber desires in the case of this word, it must be also indicated by the orthography or by some graphic mark of quantity. Hence the word must be treated lexicographically as either *clōn* or *clone*. If written simply *clon*, everyone would be justified in pronouncing it *clŏn*.

Charles Louis Pollard.

Springfield, Mass.

[1] Science, XVIII., 501–503, 1903.

SPECIAL ARTICLES.

A DIAGRAM OR CHART FOR FINDING THE SUN'S AZIMUTH.

In Science for July 24, 1903, under the title 'On Uses of a Drawing Board and Scales in Trigonometry and Navigation,' I have briefly described such simple apparatus as seemed to be most serviceable in the solution of spherical triangles. What is written here may be regarded as a continuation of that article, because the apparatus there described can be used in place of the azimuth diagram and in ways quite analogous to those here outlined.

Given two sides of a spherical triangle and the included angle, to find one of the remaining angles without first finding the side op-

posite the given angle. Let b, c and A denote the given parts and C the required angle. From the fundamental equations

$$\cos a = \cos b \cos c + \sin b \sin c \cos A, \quad (1)$$
$$\cos c = \cos a \cos b + \sin a \sin b \cos C, \quad (2)$$
$$\sin C \sin a = \sin A \sin c, \quad (3)$$

the quantity a may be eliminated by first dividing (1) by (3), then (2) by (3) with its members interchanged, and then comparing these results. After reducing to a simple form, there results the well-known equation

$$\sin A \cot C = \sin b \cot c - \cos A \cos b. \quad (4)$$

If we write

$$x = \cos A \cos b \sin c - \sin b \cos c, \quad (5)$$
$$y = \sin A \sin c, \quad (6)$$

then

$$\frac{x}{y} = -\cot C, \quad \frac{y}{x} = -\tan C. \quad (7)$$

Since we are here concerned only with the ratio of x and y it is convenient to write

$$x = \cos A \cos b - \sin b \cot c, \quad (8)$$
$$y = \sin A, \quad (9)$$

provided $\cot c$ does not become too great, and the ratio x/y or y/x will remain as before.

The azimuth diagram or chart may be described by aid of a sketch, Fig. 1. The radii of the system of concentric semicircles are equal to $\sin \theta$ where θ varies from 0° to 90°, counting from the center, or to $\cos \theta$ where θ varies from 0° to 90°, counting towards the center. A system of straight lines radiate from the common center of the semicircular arcs. The angles formed by these lines and the initial line are written in the margin of the diagram. Although not shown in the sketch, the entire diagram is covered by systems of horizontal and vertical lines differing in color or character from the lines already referred to. The entire sheet is thus divided into small squares, the purpose being to enable one to work accurately even if the paper should become somewhat distorted and also to work without marking up the permanent diagram.

If we locate the point x, y upon the azimuth diagram, then by (7) the angle at the center which this point makes with the direction $-x$ is the angle C.

The product $\sin b \cot c$ of (8) is positive or negative according as c lies between 0° and 90° or 90° and 180°. Its numerical value is the horizontal distance from the central vertical line, measured on a level with the vertex of the circle whose radius is $\sin b$, to the radiating line numbered c.

Upon the radiating line which makes the angle A with the initial direction, mark two points, one where it crosses the outer circle and one where it crosses the circle whose radius is $\cos b$. Follow the horizontal and vertical straight lines until a point is found on a level with the first point and on the vertical passing through the second point.

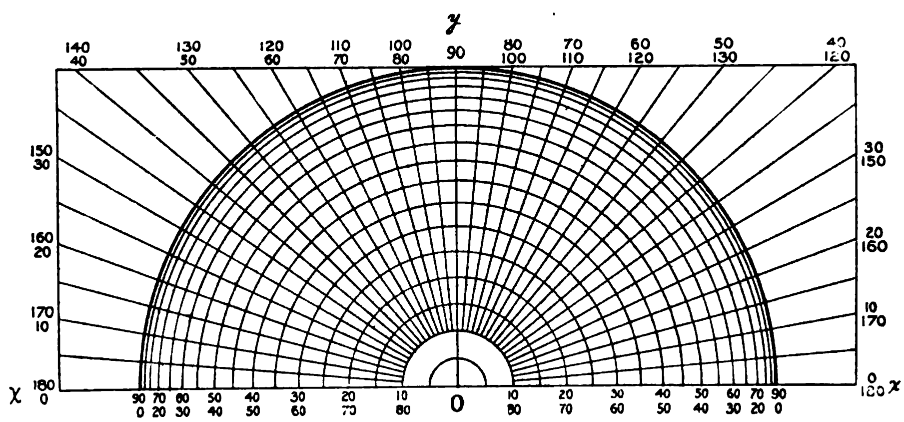

FIG. 1.

Go from this point in a horizontal direction the distance $-\sin b \cot c$. The point thus located is x, y.

When b is greater than 90°, solve the triangle whose given parts are $A, b' = 180° - b$, and $c' = 180° - c$.

Given the latitude of the place and the declination of the sun, to find the true azimuth of the sun at any given apparent time.

Let λ denote the latitude of the place and δ the declination of the sun, north declination being regarded as positive. The product $\cos\lambda \tan\delta$ is positive for north declination and negative for south. Its numerical value is the vertical distance from the horizontal initial line, measured along the vertical line which is distant $\cos\lambda$ from the central line, to the radiating line numbered δ.

Upon the radiating line which makes the (hour) angle A with the initial direction $(+x)$, mark two points, one where it crosses the outer circle, the other where it crosses the circle whose radius is $\sin\lambda$; see Fig. 2. Follow the horizontal and vertical straight lines until a point is found on a level with the first point and on the vertical passing through the second. Go from this point in a horizontal direction the distance $\pm \cos\lambda \tan\delta$, and so locate a fourth point (x, y). The angle at the center between the direction $-x$ and this point is the sun's true azimuth (C) from the north in the northern hemisphere and from the south in the southern. In Fig. 2 as drawn $A = 45° = 3$ hours; $\lambda = 40°$ N.; $\delta = 20°$ N.; $C = 103° 57'$, showing that the azimuth of the sun is then 103° 57′ from the north or 76° 3′ from the south.

A rectangular sheet of waste paper facilitates the determination of the product $\cos\lambda \tan\delta$ and the application of this quantity to locating the point x, y.

If while making a survey λ and δ be regarded as constant, the azimuth of the sun at any given hour and minute can be obtained with great facility.

The uses of the azimuth diagram in great circle sailing and in cartography are too obvious to require comment.

Experience shows that if the radius of the outer circle of the diagram is 16⅔ inches and the circles and the radiating lines go by half degrees, the azimuth under reasonably favorable conditions can easily be found to within about three minutes of its true value.

It is obvious that if two of the three given parts of a triangle are opposites, the unknown part opposite the third given part can readily be ascertained by means of the diagram, because all such products as $\sin C \sin a$, or $\sin A \sin c$, or $\sin A \sin b$ are thereon represented. Such solutions of right-angled triangles as involve only sine or cosine factors can therefore be obtained.

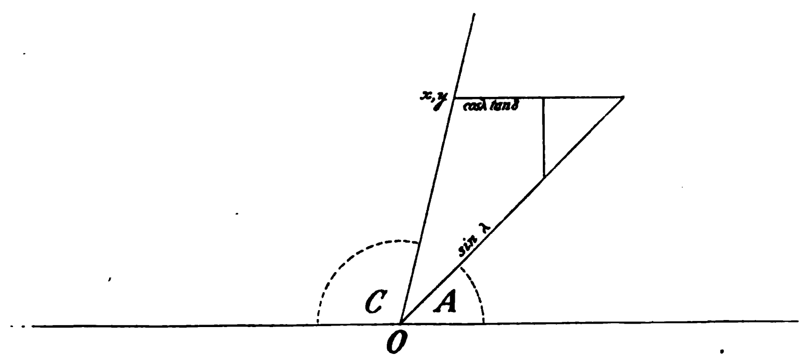

FIG. 2.

If the x and y of (8) and (9) can not be used on account of the term involving a cotangent, the required angle can still be determined by aid of the diagram, although not as easily as before, because equations (5) and (6) are more complicated than are equations (8) and (9).

The diagram enables one to find such products as those involved in equation (4), and so a graphic solution of this equation as it stands can be carried out if desired.

Since the radiating lines cut the lines $x = \pm 1$ and $y = 1$ in scales of tangents and cotangents, such products as cot b tan c, if the factors are not too great, can be obtained by first finding cot b in the upper margin of the diagram and then going downward (keeping at a distance cot b from the central line) until meeting the radiating line numbered c. The distance thence to the initial or base line is cot b tan c. The cosine scale of the diagram enables one to find the angle whose cosine is equivalent to cot b tan c. This is the angle A of a spherical triangle right-angled at B. R. A. HARRIS.

ANALYSIS OF THE MISSISSIPPI RIVER.

A SHORT time ago, in conversation with Dr. E. W. Hilgard, of the University of California, I learned, to my great astonishment, that he had been unable to find in any publication a recent and complete analysis of the Mississippi River. Deeming this a serious oversight on the part of chemists at large, a sample was secured for me through the kindness of Mr. J. L. Porter, chemist for the New Orleans City Sewerage and Water Board, and analyzed by me with the greatest of care. The methods employed in the mineral analysis were very similar to those recommended by Professor Bailey, of the Kansas Geological Survey, while the nitrogen determinations were patterned after those made by the Massachusetts State Board of Health.

The sample was taken by J. L. Porter, chemist of the New Orleans City Sewerage and Water Board about noon of May 23, 1905. Location of the sample was opposite Nine Mile point just above Carrollton, in midstream, and about six feet below the surface. Temperature of the water at the time was 23° C. Turbidity was about twice the average for the year. Oxygen was about one hundred per cent. of saturation and the free carbonic acid about three parts per hundred thousand.

The results of the analysis are as follows:

Results of Analysis Expressed in Parts per 100,000.

Total solids (unfiltered)	106.9
Total solids (filtered)	16.75
Loss on ignition (unfiltered)	7.4
Loss on ignition (filtered)	2.75
Si	0.35
Al	0.009
Mn	0.012
Ca	2.95
Mg	0.68
Fe	0.008
K	0.23
Na	1.00
SO_4	2.87
PO_4	0.04
CO_3	0.00
HCO_3	11.04
Cl	1.61
Nitrogen as free ammonia	0.016
Nitrogen as albumenoid ammonia	0.014
Nitrogen as nitrites	0.000
Nitrogen as nitrates	0.023
Oxygen consumed (unfiltered)	1.42
Oxygen consumed (filtered)	0.33
Hardness	10.92
Turbidity	Heavy.
Sediment	Large.
Odor (cold)	Practically none.

Results of Analysis Calculated as Oxides.

SiO_2	0.74
Al_2O_3	0.017
Fe_2O_3	0.011
Mn_3O_4	0.016
CaO	4.12
MgO	1.13
K_2O	0.28
Na_2O	1.35
SO_3	2.39
CO_2	7.96

The silica was rather higher than I expected, being about the same as that found in the Hot Springs of Arkansas by Mr. Haywood. Still, it is not a quarter of that occurring in many of our western streams. The ratio of lime to magnesia is about normal, as is the ratio of Na_2O to K_2O, but the amount of bicarbonate seems unusually large, indicating a large percentage of drainage from the arid lands to the northwest. Sulphates form a rather large per cent. of the total solids, but this also is to be expected when we consider

the drainage area from which the river is fed. The nitrates are a little higher than is usual in May, but the free and albumenoid ammonias compare very well with the results obtained by the New Orleans City Sewerage and Water Board. The silt varies very largely from month to month, hence no reliable conclusion can be drawn from any one analysis. This silt was saved and will be subjected to a plant food analysis at a later date.

In conclusion, let me say that this analysis has, to my mind, demonstrated the desirability of a very complete and detailed chemical study, month by month, of the Mississippi River and its tributaries, and I should have undertaken such a study personally had I not learned that it was already planned for by Mr. M. O. Leighton, in charge of the Division of Hydro-economics, U. S. Geological Survey.

C. H. STONE.

U. S. GEOLOGICAL SURVEY,
RECLAMATION SERVICE LABORATORY.

FUNCTIONS OF A TRANSPLANTED KIDNEY.

THE state of the circulation and of the secretion of a transplanted kidney has been observed on an animal operated on in this laboratory. A careful investigation of the literature has revealed no mention of a similar experiment having been performed hitherto.

The kidney of a small-sized dog was extirpated and transplanted into the neck. The renal artery was united to the carotid artery, the renal vein to the external jugular vein and the ureter to the œsophagus. Three days after the operation the neck and the abdomen were opened, in order to study the functions of the transplanted kidney and to compare them with the functions of the normal kidney. The transplanted kidney was found adherent to the muscles, and dissection was necessary to free it. In size it was larger than the normal kidney. Its hue was darker. To the touch the consistency of its tissue was normal, and the pulsations of its artery were as strong as the pulsations of the artery of the normal kidney.

Here is the summary of this observation: *the circulation in the transplanted kidney* was slightly greater than in the normal kidney, as detected by the touch, copiousness of hemorrhage from incision in cortex, and pulse-tracings.

The secretion of urine by the transplanted kidney was about five times more rapid than by the normal one. The intravenous injection of sodium chloride solution caused no change in the rate of secretion in the normal, but markedly increased the rate of the secretion in the transplanted organ.

The composition of urine secreted by the transplanted kidney differed somewhat from that secreted by the normal one. The constituents were similar, but the chlorides appeared to be more abundant in the urine from the transplanted kidney, while the organic sulphates, pigments and urea were more abundant in the urine from the normal organ.

ALEXIS CARREL,
C. C. GUTHRIE.

THE HULL PHYSIOLOGICAL LABORATORY,
UNIVERSITY OF CHICAGO.

THE UNIVERSITY OF FLORIDA.

THE state legislature of Florida during its recent session, April 4 to June 2 of the present year, enacted a measure, commonly known as the 'Buckman Bill' designed by its originators to consolidate and strengthen, and to economize in the running expenses of the educational system of the state. By the provisions of the bill the entire system of higher education, consisting of a state university, a girls' college, and including the normal school for colored students and the institute for the deaf and blind, is under the management of a single board of control of five members appointed by the governor from five sections of the state. By the terms of the bill existing state schools are abolished as follows: The University of Florida, Lake City; Florida State College, Tallahassee; Normal School, DeFuniac Springs; East Florida Seminary, Gainsville; South Florida College, Bartow; Florida Agricultural Institute, Osceola County; and the Normal and Industrial department maintained by the state in the St. Petersburg Normal and Industrial School. To replace these abolished institutions there is created a University of the State of Florida

and a State College for Girls. It is required that the university be located at some central point in the state, both geographically and as to population, and with due consideration for the lands, grounds and buildings already in the possession of the state; and that the girls' college be located on the site of some one of the abolished institutions. The actual selecting of sites for these two institutions is left in the hands of the board of control in joint action with the state board of education. The organization and future management of the two institutions is left to the board of control, subject to the approval of the board of education.

Both institutions have been organized and it is announced that they will open to receive students on September 27. The girls' college has been located at Tallahassee, on the site of the former Florida State College. The city of Gainsville was selected by the boards in joint session as the permanent location of the university. It has been decided, however, that the new university shall continue on the site of the abolished university for one year, or until the grounds at Gainsville are ready for its reception.

The state university, as established, consists of: A department of agriculture, mechanical and industrial arts; a science and classical department; a normal department; and 'such other departments as may from time to time be determined upon and added at any joint meeting of the state board of education with the board of control.' The state experiment station retains its connection with the university.

The Buckman bill carries an appropriation of $150,000 for the maintenance of the four institutions under the management of the board of control for the ensuing two years. The city of Gainsville has donated a tract of five hundred acres of land as a site for the university and experiment station, and $40,000 to be used in the erection of buildings, and has offered $30,000 to the state for the buildings formerly occupied by the East Florida Seminary. The agricultural department and the experiment station receive the benefit of the government funds accruing to them from the Morrill and Hatch acts.

Dr. Andrew Sledd, Randolph-Macon College, Harvard and Yale Universities, and president of the former University of Florida, has been secured as president. The heads of the science departments, all of whom occupied their respective positions in the abolished University of Florida, are as follows: Edward R. Flint, Massachusetts Agricultural College and Göttingen, chemistry; Karl Schmitt, Berlin and Marburg, mathematics; C. M. Connor, Michigan Agricultural College and University of Missouri, agriculture; F. M. Rolfs, Iowa State College and Colorado Agricultural College, botany and horticulture; M. T. Hochstrasser, Georgia School of Technology, mechanical engineering; J. R. Benton, Trinity College and Göttingen, physics and civil engineering; E. H. Sellards, University of Kansas and Yale University, zoology and geology.

STATIONS FOR THE DETERMINATION OF THE VARIATIONS OF LATITUDE.

SINCE the plan to make observations to determine the variations of latitude in the southern hemisphere in addition to those being made in the northern hemisphere was announced in SCIENCE, the Central Bureau of the International Geodetic Association has definitely selected the two stations to be occupied and the observations will begin on January 1, 1906.

One station is in South America, at Oncativo, a village in the Argentine Republic, on the Argentine Central Railway, 72 kilometers from Cordova and 622 kilometers from Buenos Ayres. It is located on a plain with favorable topographic and climatic conditions. The temperature ranges from $-6°$ to $+40°$ (Centigrade) and the mean cloudiness during the year is expressed by 4 on the customary scale. The rainy season occurs in summer, when the rainfall amounts to 700 mm. Dr. Luigi Carnera has been appointed observer.

The other station is in Australia, at Bayswater, a town 6 kilometers northeast of Perth, the capital of West Australia. There the annual range of temperature is between 0°

and $+40°$ and the mean cloudiness varies from 2 in summer to 5 in winter. The annual rainfall amounts to 870 mm. Dr. Curt Hessen will be in charge of the observatory.

Both these stations are in latitude $-31°$ $55'$.

At the Observatory of Pulkowa, in latitude $+59°$ $46'$, a series of observations is in progress to supplement the observations at the stations of the International Geodetic Association and it is expected that the observatories at Leyden (latitude $+52°$ $09'$) and at Tokyo (latitude $+35°$ $39'$) will cooperate in this work.

PROFESSOR BJERKNES'S LECTURES.

THE lectures which Professor V. F. K. Bjerknes, of the University of Stockholm, will give at Columbia University during December are as follows:

FIELDS OF FORCE.

Friday, December 1, 1905, 4 to 6 P.M.: 'Elementary Investigation of the Geometric Properties of Hydrodynamic Fields' (with experiments).

Saturday, December 2, 1905, 10 to 12 A.M.: 'Elementary Investigation of the Geometric Properties of Hydrodynamic Fields' (with experiments).

Friday, December 8, 1905, 4 to 6 P.M.: 'Geometric Properties of Electromagnetic Fields According to Maxwell's Theory.'

Saturday, December 9, 1905, 10 to 12 A.M.: 'The Dynamic Properties of Electromagnetic Fields according to Maxwell's Theory.'

Friday, December 15, 1905, 4 to 6 P.M.: 'Transformation of the Hydrodynamic Equations to Forms which prove the Analogy of Hydrodynamic and Stationary Electromagnetic Fields.'

Saturday, December 16, 1905, 10 to 12 A.M.: 'Further Development and Discussion of the above Analogy.'

Friday, December 22, 1905, 4 to 6 P.M.: 'General Conclusions: Remarks on Methods of Research and of Instruction in Theoretical Physics.'

Saturday, December 23, 1905, 10 to 12 A.M.: 'Supplementary Lecture: The Hydrodynamic Fields of Force in the Atmosphere and the Sea; Discussion of the Fundamental Problem of Meteorology and Hydrography.'

The lectures will be open without charge to teachers and advanced students of physics.

PERMIAN GLACIATION IN SOUTH AFRICA.

THE following note of greeting has been addressed to Professor T. C. Chamberlin, of the Unversity of Chicago:

Members and guests of the British Association in South Africa, returning from a geological excursion, provided by the hospitality of the Natal government, send you greetings and wish you might have been with us to-day to see the Dwyka glacial formation (Permian) lying on a glaciated surface of Barberton (Archæan?) beds. The evidence of extensive glaciation, with *southward* movement of the vast ice sheet, is not to be doubted.

J. LOMAS, Liverpool.
G. N. MOLENGRAAFF, Johannesburg.
A. PENCK, Vienna.
B. HOBSON, Manchester.
DR. PR. BECK, Freiberg.
WILLIAM ANDERSON, Natal.
A. P. COLEMAN, Toronto.
F. G. KATZENSTEIN, Vryheid, Natal.
W. M. DAVIS, Cambridge, Mass.

VRYHEID, DISTR. NATAL,
Aug. 26, 1905.

SCIENTIFIC NOTES AND NEWS.

WE regret to learn that the condition of Dr. William R. Harper, president of the University of Chicago, is now very serious.

PROFESSOR EBERTH, director of the Pathological Institute in Halle and discoverer of the bacillus of typhoid fever, celebrated his seventieth birthday on September 21.

PROFESSOR FRANKLIN C. ROBINSON, head of the department of chemistry of Bowdoin College, has been elected president of the American Public Health Association, which will hold its annual meeting in January in the city of Mexico.

PROFESSOR WILHELM OSTWALD, of Leipzig, who, as we have already announced, will give courses in physical chemistry and philosophy at Harvard University during the first half of the present academic year, arrived at Cambridge on the second instant.

PROFESSOR J. A. HOLMES, of the University of North Carolina, is in Germany to investigate for the U. S. Geological Survey the use of brown lignite bricquettes for fuel and methods of protecting railway ties.

Dr. Wyssling, professor of electrical engineering in the Polytechnic Institute at Zurich, and Charles Wirth, also of Zurich, are in this country, to prepare a report on electrical railway development for the Swiss government.

The opening address to the students of the medical faculty of McGill University was delivered, on September 19, by Dr. Abraham Jacobi, emeritus professor at Columbia University. In the evening he was the guest of honor at a banquet.

During the coming January Mr. Bailey Willis, of the United States Geological Survey and the Carnegie Institution, will present a course of twelve lectures in the geological department of the University of Wisconsin on the subject of 'Continental Variations, with Special Reference to North America.'

Mr. E. E. Ellis has recently completed for the Division of Hydrology, U. S. Geological Survey, an investigation of the occurrence of groundwater in crystalline rocks of Connecticut. The results show that the supplies to be obtained from such rocks are much greater than is usually supposed, that the water is frequently under artesian pressure, and that its occurrence has a very definite relation to the presence of overlying drift.

Mr. Carl Schaeffer has just returned from southwestern Arizona, where he has been collecting insects for the last three months in the interest of the Museum of the Brooklyn Institute. His trip has been very successful and he has obtained many rare and some new species, the beetles being represented by the largest number of species and specimens. He secured a few specimens of the very rare tiger beetle, *Amblychila heroni*, only three or four specimens of which were previously known in collections. A few specimens of *Gymnetes cretacea*, were secured and two other species of the same genus new to the fauna of the United States. The collection of moths includes a number of rare species, some being heretofore represented by a single specimen and some that have recently been thrown out of lists, having been considered as wrongly attributed to our fauna. As soon as time permits, the material will be worked up and the results published.

The house at Ithaca occupied by the late Professor R. H. Thurston has been purchased by Mr. Hiram W. Sibley and given to the university as a residence for the director of Sibley College.

Professor DeWitt Bristol Brace, Ph.D. (Berlin), head of the department of physics in the University of Nebraska, and one of the leading physicists of the United States, died at his home in Lincoln, Nebr., on October 2, at 2 o'clock in the afternoon. He was in his forty-seventh year, and had just entered upon his nineteenth year of teaching in the University of Nebraska.

Baron Ferdinand von Richthofen, professor of geography in the University of Berlin, died on October 7, at the age of seventy-two years.

The death is also announced of Mr. George Bowdler Buckton, F.R.S., a leading British entomologist.

The International Tuberculosis Congress will hold its next meeting in Washington in 1908. At the closing session of the Paris Congress, on October 7, Professor Behring made a statement relative to his new curative principle for tuberculosis. According to a cablegram published in the daily papers he said: "In the course of the last two years I recognized with certainty the existence of a curative principle completely different from the antitoxic principle. This new curative principle plays an essential rôle in the operation of the immunity derived from my bovo-vaccine, which has proved effective against animal tuberculosis during the past four years. This curative principle reposes upon the impregnation of the living cells of the organism with a substance originating from tuberculose virus, which substance I designate 'T. C.'" Professor Behring then gave a technical description of how 'T. C.' was introduced into the cellular organism, and said it had already given marked results in the treatment of animals. He expressed the confident belief that his researches would permit similar curative results in man. He added that he was unable

to say how soon positive results would be obtainable, but he felt as certain that these results would be attained as when he first announced his discovery of a new method for treating diphtheria.

THE conference of the International Union for Cooperation in Solar Research was concluded on September 29, in New College, Oxford. It was resolved to accept the invitation of M. Janssen to meet at Meudon in September, 1907. Professors Schuster (chairman) and Hale were elected members of the executive committee. It was decided that the central bureau should be at the University of Manchester, and that the computing bureau should be at the University Observatory, Oxford, under the direction of Professor Turner. Committees were elected to deal with the following four subjects: (1) Standards of wavelength; (2) solar radiation; (3) cooperation in work with the spectro-heliograph; (4) cooperation in work on the spectra of sun-spots.

THERE will be a New York state civil service examination on October 28, to fill the position of assistant in botany in the science division of the Education Department with a salary of $600, for assistant in microscopy in the Buffalo Cancer Laboratory with a salary of $720, and of Bertillon clerk in the state prison with a salary of $900.

THE *Vingtième Siècle,* according to a Reuter telegram from Brussels, announces that, upon the initiative of the king of the Belgians, the polar explorers MM. Lecointe and Arktovski, of the *Belgica* expedition, Professor Nordenskiöld and Messrs. Bruce and Shackleton had a meeting after the sitting of the Mons Congress. The result of their deliberations was that a scheme for international expeditions to the North and South Poles was to be laid before the fifth section of the congress. It is proposed that these expeditions shall be organized through the good offices of the various governments interested in the scheme, and that monster subscriptions shall be opened for the purpose. The government of the king of the Belgians will play a great part in the organization of the expeditions. The polar explorers Sverdrup and Nansen (Norway), the Duke of the Abruzzi (Italy), Von Drygalski (Germany), Charcot (France), De Gerlache and Rakovitza (Belgium) and Cook and Peary (United States), who had been summoned to the meeting, were prevented from attending, but they wrote offering their support to the enterprise. Numerous subscriptions have already been received. A Reuter telegram from Mons states that the fifth section of the Congress on Polar Exploration has unanimously adopted a resolution in favor of the scheme.

The New York Medical Record states that the department of agriculture of the University of California has been engaged for several years in the study of the diseases of the insects that destroy various crops in this and other states, and in several instances have met with great success. Since July, Professor Clarke, assistant entomologist, had been studying a bacterial disease that completely exterminated the grasshoppers at Los Banos. The disease was of unknown origin and in the course of a month destroyed a countless army of the insects, after they had entirely devoured the alfalfa crop.

THE outlook for a profitable mining industry in the Philippine Islands is more hopeful to-day than it has been at any time since the American occupation, according to a brief report written by Mr. H. D. McCaskey, chief of the Mining Bureau, Philippine Islands, and published as an extract from the annual volume of the United States Geological Survey entitled 'Mineral Resources of the United States, 1904.' Mining development is now carried on in the provinces of Lepanto-Bontoc, Benguet, Pangasinan, Nueva Ecija, Bulacan, Rizal, Batangas, Tayabas, Camarines, Albay, Masbate, Cebu and Mindanao, and prospecting is being done in almost every island and province of the archipelago.

THE approaching session of the Royal Geographical Society, under the auspices of the new president, Sir George Goldie, promises, says the London *Times,* to be a busy one. It begins a week earlier than usual, and there will be four ordinary meetings before Christmas. The first meeting will be held on November 6, when the president will make a few introductory remarks, to be followed by a

paper on the mountains of Central Japan, by the Rev. Walter Weston. At the meeting on November 20, Mrs. Fanny Bullock Workman will give an account of the first exploration by herself and her husband of the Hoh-Lumba and Lobson glaciers, in the western Himalayas. On December 4, Mr. H. Weld Blundell will give a paper on the very interesting investigations he has been making on the Abai basin, in Abyssinia. On December 18, Mr. C. G. Seligman will give an account of the recent expedition to British New Guinea, under Major Daniels; the paper will be illustrated with cinematograph slides showing after a vivid fashion some of the customs of the natives. Among papers to be expected after Christmas are the following: 'Unexplored India,' by Colonel Sir T. H. Holdich; 'The Economic Geography of Australia,' by Professor J. W. Gregory, F.R.S.; 'Survey and Exploration in Seistan,' by Colonel A. H. McMahon, C.S.I.; 'Exploration in Tierra del Fuego,' by Captain R. Crawshay; 'Exploration in the East Tibet Borderlands,' by Lieutenant Filchner; 'Explorations in Bolivia and Peru,' by Baron E. Nordenskjöld; 'The Philippine Islands,' by Professor Alleyne Ireland; 'Northern Rhodesia,' by L. A. Wallace; 'The Geographical Influence of Water Plants in Chile,' by G. F. Scott Elliot; 'Maps of London,' by Laurence Gomme. Major St. Hill Gibbons will give a paper dealing with some of the results of his recent expedition to British East Africa in connection with the Zionist Association, and a paper on 'The Geography of the Spanish Armada' may be expected from the Rev. W. Spotswood Green. In addition to the ordinary evening meetings of the society, the research department, instituted about two years ago, holds frequent afternoon meetings for the discussion of special subjects in scientific and applied geography. The scheme for the investigation of the changes which have taken place in the North Sea Coast region during historical times will be further considered, and it is hoped active steps will be instituted for carrying out the inquiry. Sir Clements Markham will introduce the question of 'The Next Great Arctic Discovery,' in which he will advocate detailed investigation of the unknown region lying between Prince Patrick Island and the New Siberian Islands. Among other subjects to be brought before this department of the society will be the results of an investigation into the areas of the orographical regions of England and Wales, by Dr. A. J. Herbertson, reader in geography at Oxford University. It is expected that the visit of the British Association to South Africa will have furnished the geographical members with certain problems in their subject suitable for discussion at the research department.

THE present is an especially favorable time to study the geologic structure of Greater New York, for never before in the earth's history has there been such a focus for engineering enterprises as is now found within the 50 or more square miles included within Manhattan Island. These enterprises have together furnished more than 35 sections across the rivers which form the water front of the island. Many of them reveal the nature of the subjacent rock, and a number of them give nearly complete section across it. In view of the rapid work of the engineers, it is important that observations be made and recorded at once lest the opportunity be forever lost. Bulletin 270 of the United States Geological Survey, which is entitled 'The Configuration of the Rock Floor of Greater New York,' is, therefore, an especially timely study. Mr. William Herbert Hobbs, the author, calls further attention to the fact that the present is a particularly favorable time for geologic observation in this vicinity, because of the enormous increase in the value of real estate upon Manhattan Island. It is resulting in a paring down of all rock masses which project above the general level in order to make room for business blocks and apartment houses. The greater number of the rock exposures described by Dana and other early observers are now no longer seen, and those still uncovered by blocks and pavements will in a very few years have disappeared from view. After reviewing briefly the structural geologic studies made in the New York City area by earlier writers, Mr. Hobbs states that too little weight, in his opinion, has been ac-

corded by recent observers to the importance of normal faulting in determining the structure of Manhattan Island. He describes a number of additional fault planes which have recently been located. The purpose of his investigation is to determine the depth and the nature of bed rock beneath Greater New York, through the medium of wells and borings, the numerous bridge and tunnel sections, the government dredgings, the reefs in mid-channel, etc. It is believed that this work will aid not only in the solution of the geological problems of the area, but will be of assistance to those engaged in the great engineering enterprises now going forward on the island, as well as to architects, contractors and many others.

The Iron and Steel Institute of Great Britain met at Sheffield on September 26, when Mr. R. A. Hatfield gave the presidential address. According to the abstract in the London *Times* he dwelt upon the large and important position which Sheffield had taken in the development of steel and its applications. As they all knew, Chaucer in 1460 spoke of Sheffield thwitels, and these still formed a not unimportant branch of Sheffield products. In the interesting works of that important French metallurgist of the eighteenth century, Jars, Sheffield was then recognized as playing a very important part in metallurgy. Sheffield had indeed been the cradle of modern steel industry, and its development had been largely due to the work of Sheffield men. They all knew how much Huntsman did, and it was a special pleasure to see there that day two of his descendants. Coming nearer to their own times, whilst Bessemer was not a Sheffield man, the first practical developments of his process might be truly said to have occurred there, and were carried out by Sheffield men. Sir John Brown, with his great foresight, saw the importance this process would occupy, and his firm turned out some of the highest quality material for rails probably yet produced. He had now in his possession an interesting photograph representing rails and bars rolled by Sir John Brown at the Atlas Works from the first rails made commercially of Bessemer's steel. This photograph had been kindly sent to him by the son of Mr. Bragge, who was then one of Sir John's partners. On it there occurred the following remarkable inscription, personally written by Mr. Bragge forty-four years ago: "This photograph was taken from the first rails ever made commercially in England of cast steel, produced by Bessemer's process, and when steel rails have superseded iron, as they certainly will do in the course of time, this picture will record who first had courage to introduce them to the world. May 1st, 1861." A remarkable prediction which had indeed come to pass. Mr. W. D. Allen, of Bessemer's firm in Sheffield, also largely helped in the practical development of this method of steel making, and the inimitable Holly, from whose work the enormous development of Bessemer steel in America largely arose, did not go to South Wales or elsewhere, but came to Sheffield to be initiated, so that Sheffield might be rightly said to have taught America how to make steel rails used in those lines of communication that had entirely altered the whole face of the vast Transatlantic continent. In the same manner as regards the Siemens's process, firms such as Vickers's were largely instrumental in leading to the more rapid development and perfection of this method of producing steel. Then, too, they saw men such as Mark Firth, William Jessop, Charles Cammell and others who were indeed pioneers, and from whose labors the world to-day found so great benefit. On the scientific side they had, amongst others, Dr. Sorby, who had rendered invaluable service to metallurgy by his initiation, as far back as 1857, of methods of examining the micro-structure of metals, from which they to-day were obtaining much valuable information. To-day Sheffield had probably the largest industrial army of any city devoted to the production and working of steel, 30,000 men or more being so employed. The work done by the institute spoke for itself, and as a sign of prosperity, he might say that they had that day elected something like 150 new members, bringing the roll-call to the satisfactory grand total of no less than 2,200 members.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. JOHN D. ROCKEFELLER has now paid to the General Education Board the $10,000,000 in accordance with the announcement made last June. The income, it will be remembered, will be distributed to promote a comprehensive system of higher education in the United States, and it is assumed, though perhaps not correctly, that the larger part will be given to the denominational colleges. The secretary of the board is the Rev. Dr. Wallace Butterick, 54 William Street, New York City.

NEW YORK UNIVERSITY receives $20,000 by the will of the late William A. Wheelock.

THE Ontario government has selected the following men to compose a commission to report on the proposed reorganization of the University of Toronto: Professor Goldwin Smith, Sir William Meredith, Byron E. Walker, J. W. Flavelle, the Rev. Canon Cody, the Rev. D. B. Macdonald and A. H. N. Colquhoun. The gathering of information and the preparation of a report for the government to act upon at the next session of the legislature will be begun at once.

THE freshman registration of the academic department at Yale University will be about 400, and the registration at the Sheffield Scientific School will be about the same. The growth of the latter school is noteworthy, the freshmen class having about doubled since 1900.

THE entering class at the University of Nebraska numbers this year 475, and the total registration will be about three thousand.

As was noted here last week, John M. Tillman, B.L.L., was formally inaugurated president of the University of Arkansas on September 20. The addresses on the occasion were as follows:

J. C. SOUTH: 'For the Board of Trustees.'

A. H. PURDUE: 'For the Faculty.'

J. C. MARSHALL: 'For the Alumni.'

W. S. SUTTON, University of Texas: 'For a Sister University.'

E. A. MCCULLOCK, Associate Justice Arkansas Supreme Court: 'Introduction of the President.'

PRESIDENT JOHN N. TILLMAN: 'Inaugural Address.'

AT the opening of the present year, Professor Henry S. White formerly of Northwestern University, assumes the duty of professor of mathematics at Vassar College.

W. J. MILLER, Ph.D. (Johns Hopkins), has been appointed to succeed Professor C. H. Smyth, Jr., in geology, at Hamilton College, and M. W. Twitchell, Ph.D. (John Hopkins), has been appointed to the chair of geology at South Carolina College, Columbia.

THE list of preceptors with the rank of assistant professors appointed under the new preceptorial system at Princeton University has now been made public. There are in all forty-four, all of whom are in languages, philosophy, history and political science, except three in mathematics and one in geology. The appointments in mathematics are L. P. Eisenhart (Princeton), William Gillespie (Princeton) and G. A. Bliss (Missouri), and in geology, Marcus S. Farr, '92 (Princeton).

DR. HENRY RAYMOND MUSSEY, of New York University, has been appointed associate professor of economics and politics at Bryn Mawr College in place of Dr. Lindley Miller Keasbey, who has resigned the chair to be head of the department of economics in the University of Texas.

CLARK WISSLER, Ph.D., and Berthold Laufer, Ph.D., have been appointed lecturers in anthropology at Columbia University.

MR. E. D. CHASE has been added to the teaching force at the Gayley Chemical Laboratory of Lafayette College.

DR. ROGER C. WELLS, formerly instructor in Harvard University, has been appointed instructor in physical chemistry at the University of Pennsylvania. Dr. Wells has begun a study of electrical conduction in melted salts.

AT Cornell University recent appointments are: E. W. Schoder, assistant professor of experimental hydraulics; C. F. Harding, assistant professor of electrical engineering, and R. M. Robertson, instructor in electrical engineering.

W. C. SABINE, assistant professor of physics at Harvard University, has been promoted to a professorship.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, OCTOBER 20, 1905.

CONTENTS.

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE RUMFORD FUND OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES.[1]

BENJAMIN THOMPSON, COUNT RUMFORD, was born at Woburn, Mass., March 26, 1753, and died at Auteuil, France, August 21, 1814. During his boyhood he showed an intense interest in scientific matters and attended scientific lectures at Harvard College. Afterwards he studied medicine, though he never practised, and taught school at Concord, N. H. He was suspected of being unfriendly to the cause of liberty in the war of the Revolution, and on the evacuation of Boston by the British —in March, 1776—he went to England.

Here he prosecuted various scientific researches, and was elected a fellow of the Royal Society in 1779. He subsequently entered the employ of Prince Maximilian of Bavaria, to whom he was of great service, reorganizing the army, instituting important social reforms, and at the same time prosecuting valuable scientific researches. Of these the most noteworthy was his well-known investigation into the cause of the heat produced by friction, by which he conclusively disproved the hypothesis of the fluid nature of heat, and laid an important stone in the foundation of the doctrine of the conservation of energy. He was created a count by Prince Maximilian, and chose the title Count Rumford, after the New Hampshire town from which the family of his wife had come.

In 1799 he returned to England, and soon after projected the Royal Institution of Great Britain. He went to France in

[1] Published by the Academy.

1804, subsequently married the widow of Lavoisier, and died in 1814. By a bequest in his will he founded the Rumford Professorship of the Application of Science to the Useful Arts in Harvard University.

The Rumford Fund had its origin in the gift by Count Rumford to the American Academy of Arts and Sciences of the sum of $5,000; which was simultaneous with the gift of a like sum, £1,000, to the Royal Society of Great Britain. The purpose of the fund was the same in each case, the award of a suitable premium for discoveries or improvements in heat and light.

The intention of the donor was announced to the academy in the following letter:

LONDON, July 12, 1796.

To the Hon. John Adams, President of the American Academy of Arts and Sciences:

SIR,—Desirous of contributing efficaciously to the advancement of a branch of science which has long employed my attention, and which appears to me to be of the highest importance to mankind, and wishing at the same time to leave a lasting testimony of my respect for the American Academy of Arts and Sciences, I take the liberty to request that the academy would do me the honor to accept of five thousand dollars, three per cent. stock in the funds of the United States of North America, which stock I have actually purchased, and which I beg leave to transfer to the fellows of the academy, to the end that the interest of the same may be by them, and by their successors, received from time to time, forever, and the amount of the same applied and given once every second year, as a premium, to the author of the most important discovery or useful improvement, which shall be made and published by printing, or in any way made known to the public, in any part of the continent of America, or in any of the American islands during the preceding two years, on heat, or on light; the preference always being given to such discoveries as shall, in the opinion of the academy, tend most to promote the good of mankind.

With regard to the formalities to be observed by the academy in their decisions upon the comparative merits of those discoveries which in the opinion of the academy may entitle their authors to be considered as competitors for this biennial premium, the academy will be pleased to adopt such regulations as they in their wisdom may judge to be proper and necessary.

But in regard to the form in which this premium is conferred, I take the liberty to request that it may always be given in two medals, struck in the same die, the one of gold and the other of silver, and of such dimensions that both of them together may be just equal in intrinsic value to the amount of interest of the aforesaid five thousand dollars stock during two years: that is to say, that they may together be of the value of three hundred dollars.

The academy will be pleased to order such device or inscription to be engraved on the die they shall cause to be prepared for striking these medals, as they may judge proper.

If during any term of two years, reckoning from the last adjudication, or from the period for the adjudication of this premium by the academy, no new discovery or improvement should be made in any part of America, relative to either of the subjects in question (heat or light), which, in the opinion of the academy shall be of sufficient importance to deserve this premium, in that case, it is my desire that the premium may not be given, but that the value of it may be reserved, and by laying out in the purchase of additional stock in the American funds may be applied to augment the capital of this premium; and that the interest of the sums by which the capital may, from time to time, be so augmented, may regularly be given in money with the two medals, and as an addition to the original premium at each succeeding adjudication of it. And it is further my particular request that those additions to the value of the premium arising from its occasional non-adjudication may be suffered to increase without limitation.

With the highest respect for the American Academy of Arts and Sciences, and the most earnest wishes for their success in their labors for the good of mankind,

I have the honor to be, with much esteem and regard, sir,

Your most obedient, humble servant,

RUMFORD.

The gift was accepted by the academy, but for many years no award of the premium was made as no claimant appeared whose merit was such in its opinion as to justify this. Meanwhile the fund had accumulated to the amount of $20,000, and

in view of the fact that there was no possibility of expending the income in the precise manner contemplated by Count Rumford, application was made in 1831 to the Supreme Court of the Commonwealth of Massachusetts for relief, if such should be possible.

The court issued a decree which modified the possible disposition of the income of the fund in such a manner as to increase its usefulness while keeping entirely within the spirit of the original gift, saying in part as follows:

It further appears that the said donation was made to the American Academy for a general purpose of charity, that, namely, of promoting a useful branch of science for the benefit of mankind; that the academy accepted the same, upon the terms stated, and for the purposes contemplated by said donation, and are now under obligation to carry the general intent of the donor into effect, as far as it is practicable to do so. It further appears, that, in consequence of the impediments set forth in the bill, it is impracticable for the academy to carry the general charitable intent of the donor into effect in the exact and precise mode specified by him; but, considering the general and primary intent of Count Rumford to have been to awaken and stimulate the ingenuity, and encourage the researches and experiments of individuals on the continent or the islands of America to make important discoveries or useful improvements upon the subjects of light and heat, and to cause them speedily to be published for the good of mankind, it does appear to the court that it is quite practicable for the academy to accomplish and carry into effect the general charitable intent and purpose of Count Rumford by some slight alterations in the mode particularly prescribed by him for carrying the same into effect.

It is therefore by the court ordered, adjudged and decreed, for the reasons set forth in the bill, that the plaintiffs be, and they are by the authority of this court, empowered to make from the income of said fund, as it now exists, at any annual meeting of the academy, instead of biennially, as directed by the said Benjamin Count Rumford, award of a gold and silver medal, being together of the intrinsic value of three hundred dollars, as a premium to the author of any important discovery or useful improvement on heat or on light which shall have been made and published by printing or in any way made known to the public, in any part of the continent of America, or any of the American islands, preference being always given to such discoveries as shall, in the opinion of the academy, tend most to promote the good of mankind; and to add to such medals as a further reward and premium of such discovery or improvement, if the plaintiffs see fit so to do, a sum of money not exceeding three hundred dollars.

And it is further ordered, adjudged and decreed, that the plaintiffs may appropriate from time to time, as the same can advantageously be done, the residue of the income of said fund hereafter to be received, and not so as aforesaid awarded in premiums, to the purchase of such books and papers and philosophical apparatus (to be the property of said academy) and in making such publications or procuring such lectures, experiments, or investigations, as shall in their opinion best facilitate and encourage the making of discoveries and improvements which may merit the premium so as aforesaid to be by them awarded. And that the books, papers and apparatus so purchased shall be used, and such lectures, experiments and investigations be delivered and made, either in the said academy or elsewhere, as the plaintiffs shall think best adapted to promote such discoveries and improvements as aforesaid, and either by the Rumford Professor of Harvard University or by any other person or persons, as to the plaintiffs shall from time to time seem best.

In considering this action of the court, Dr. George E. Ellis, the biographer of Count Rumford, makes the following comment:

It is easy to express the obvious suggestion, that the enlargement and direction thus allowed by judicial decision to the use of the trust fund committed by Count Rumford to the academy, for one specified and well-defined object, exceed any possible construction that can be put upon the liberal terms of his deed of gift. But it is just as easy to meet the suggestion by affirming that the judicial decree has in view, and aims, it may even be said, most conscientiously to fulfil the intent of the donor. Under its decision the academy may make the munificence of Count Rumford most serviceable at the fountain-head and sources of that scientific development which alone can secure biennially, or at longer or shorter in-

tervals, a signal result marking a point in the flow of the stream. Books and lectures presenting the last discoveries, or methods for discovery, in the count's favorite subjects of experiment, may be regarded as even something better than an alternative in the improvement of his fund, to the use of it for a medal or premium under the pressure of a supposed obligation to bestow it with chief reference to the lapse of two years.

In view of all the circumstances and of the difficulties which the case presented, one may reasonably affirm that when the honored and venerated chief-justice gave validity to the decree of the court, he might have felt the full assurance that Count Rumford himself would have dictated its terms.

At the close of the last fiscal year of the academy (1904–05) the Rumford Fund amounted to $58,722.16, the income for that year having been $2,550.73.

A standing committee of the academy known as the Rumford Committee, consisting of seven fellows, is charged with the supervision of the trust created by Count Rumford, and considers all applications and claims for the Rumford premium, and all applications made for grants from the income of the fund in aid of research or for other purposes.

The Rumford Committee was first constituted a standing committee in 1833. Its members were nominated annually by the president of the academy until 1863, since which time they have been chosen in the same manner as the other officers.

The following is a list of those who have been members of the committee:

MEMBERS OF THE RUMFORD COMMITTEE, 1833–1905.

1833–1838, Nathaniel Bowditch.
1833–1837, Francis C. Gray.
1833–1848, Daniel Treadwell.
1833–1846, Jacob Bigelow.
1833–1849, John Ware.
1837–1846, John Pickering.
1838–1839, James Jackson.
1839–1840, Benjamin Peirce.
1840–1843, George B. Emerson.
1843–1849, Benjamin Peirce.
1846–1850, Francis C. Lowell.
1846–1847, James Hayward.
1847–1868, Joseph Lovering.
1848–1863, Eben N. Horsford.
1849–1863, Daniel Treadwell.
1849–1878, Morrill Wyman.
1850–1862, Henry L. Eustis.
1862–1871, Joseph Winlock.
1863–1869, William B. Rogers.
1863–1864, Charles W. Eliot.
1863–1864, Theophilus Parsons.
1863–1866, Cyrus M. Warren.
1864–1894, Wolcott Gibbs.
1864–1871, Francis H. Storer.
1866–1877, Josiah P. Cooke.
1868–1878, James B. Francis.
1869–1890, Edward C. Pickering.
1871–1885, John M. Ordway.
1871–1880, Stephen P. Ruggles.
1877–1897, John Trowbridge.
1878–1892, Josiah P. Cooke.
1878–1892, Joseph Lovering.
1880–1891, George B. Clark.
1885– Erasmus D. Leavitt.
1890–1896, Benjamin O. Peirce.
1892– Edward C. Pickering.
1892– Amos E. Dolbear.
1892– Charles R. Cross.
1894–1896, Benjamin A. Gould.
1896– Arthur G. Webster.
1897–1902, Thomas C. Mendenhall.
1897– Theodore W. Richards.
1902– Elihu Thomson.

The successive chairmen of the Rumford Committee up to the present time have been the following: Messrs. Nathaniel Bowditch (1833–1838), James Jackson (1838–1839), John Pickering (1839–1846), Daniel Treadwell (1846–1848), Eben N. Horsford (1848–1863), Joseph Lovering (1863–1868), Joseph Winlock (1868–1871), Josiah P. Cooke (1871–1876), Morrill Wyman (1876–1878), Joseph Lovering (1878–1892), John Trowbridge (1892–1897), Charles R. Cross (1897–).

The Rumford premium is awarded by the academy upon the recommendation of the Rumford Committee. It has been given to the following persons and on the ground stated:

AWARDS OF THE RUMFORD PREMIUM OF THE AMERICAN ACADEMY.

1839. Robert Hare, of Philadelphia, for his invention of the compound or oxyhydrogen blowpipe.

1862. John Ericsson, of New York, for his improvements in the management of heat, particularly as shown in his caloric engine of 1855.

1865. Daniel Treadwell, of Cambridge, for improvements in the management of heat, embodied in his investigations and inventions relating to the construction of cannon of large calibre, and of great strength and endurance.

1866. Alvan Clark, of Cambridge, for his improvements in the manufacture of refracting telescopes, as exhibited in his method of local correction.

1869. George Henry Corliss, of Providence, for his improvement in the steam-engine.

1871. Joseph Harrison, Jr., of Philadelphia, for his mode of constructing steam-boilers, by which great safety has been secured.

1873. Lewis Morris Rutherfurd, of New York, for his improvements in the processes and methods of astronomical photography.

1875. John William Draper, of New York, for his researches on radiant energy.

1880. Josiah Willard Gibbs, of New Haven, for his researches in thermodynamics.

1883. Henry Augustus Rowland, of Baltimore, for his researches in light and heat.

1886. Samuel Pierpont Langley, of Allegheny, for his researches in radiant energy.

1888. Albert Abraham Michelson, of Cleveland, for his determination of the velocity of light, for his researches upon the motion of the luminiferous ether, and for his work on the absolute determination of the wave-lengths of light.

1891. Edward Charles Pickering, of Cambridge, for his work on the photometry of the stars and upon stellar spectra.

1895. Thomas Alva Edison, of Orange, N. J., for his investigations in electric lighting.

1898. James Edward Keeler, of Allegheny, for his application of the spectroscope to astronomical problems, and especially for his investigations of the proper motions of the nebulæ, and the physical constitution of the rings of the planet Saturn, by the use of that instrument.

1899. Charles Francis Brush, of Cleveland, for the practical development of electric arc-lighting.

1900. Carl Barus, of Providence, for his various researches in heat.

1901. Elihu Thomson, of Lynn, for his inventions in electric welding and lighting.

1902. George Ellery Hale, of Chicago, for his investigations in solar and stellar physics and in particular for the invention and perfection of the spectro-heliograph.

1904. Ernest Fox Nichols, of New York, for his researches on radiation, particularly on the pressure due to radiation, the heat of the stars, and the infra-red spectrum.

The Rumford Fund of the Royal Society has been devoted solely to the award of the premium according to the original provisions of that trust. For purposes of comparison with the foregoing the following list of grantees of the Royal Society's Rumford Premium is given:

AWARDS OF THE RUMFORD PREMIUM OF THE ROYAL SOCIETY.

1802. Benjamin Count Rumford, for his various discoveries respecting light and heat.

1804. John Leslie, experiments on heat.

1806. William Murdock, publication on the employment of gas from coal for the purpose of illumination.

1810. Etienne Louis Malus, discovery of certain properties of reflected light.

1814. William Charles Wells, essay on dew.

1816. Humphry Davy, papers on combustion and flame.

1818. David Brewster, discoveries relating to the polarization of light.

1824. Augustin Jean Fresnel, development of the undulatory theory, as applied to the phenomena of polarized light: and various important discoveries in physical optics.

1832. John Frederic Daniell, experiments with a new register pyrometer for measuring the expansion of solids.

1834. Macedonio Melloni, discoveries relative to radiant heat.

1838. James David Forbes, experiments on the polarization of heat.

1840. Jean Baptiste Biot, researches in and connected with the circular polarization of light.

1842. Henry Fox Talbot, discoveries and improvements in photography.

1846. Michael Faraday, discovery of the optical phenomena developed by the action of magnets and electric currents in certain transparent media.

1848. Henri Victor Regnault, experiments on expansion and density of air, different gases and mercury.

1850. François Jean Dominique Arago, experimental investigation of polarized light.

1852. George Gabriel Stokes, on the change of refrangibility of light.

1854. Neil Arnott, a new smoke-consuming and fuel-saving fireplace.

1856. Louis Pasteur, discovery of the nature of racemic acid, and its relations to polarized light.

1858. Jules Célestin Jamin, various experimental researches on light.

1860. James Clerk Maxwell, researches on the composition of colors and other optical papers.

1862. Gustav Robert Kirchhoff, researches on the fixed lines of the solar spectrum and on the inversion of the bright lines in the spectra of artificial light.

1864. John Tyndall, researches on the absorption and radiation of heat by gases and vapors.

1866. Armand Hippolyte Louis Fizeau, optical researches and investigations into the effect of heat on the refractive power of transparent bodies.

1868. Balfour Stewart, researches on the qualitative as well as quantitative relations between the powers of emission and absorption of bodies for heat and light.

1870. Alfred Olivier Des Cloizeaux, researches in mineralogical optics.

1872. Anders Jonas Angström, researches on spectral analysis.

1874. Joseph Norman Lockyer, spectroscopic researches on the sun and on the chemical elements.

1876. Pierre Jules César Janssen, researches on the radiation and absorption of light, carried on chiefly by means of the spectroscope.

1878. Alfred Cornu, optical researches, and especially his recent redetermination of the velocity of propagation of light.

1880. William Huggins, astronomical researches.

1882. William de Wiveleslie Abney, contributions to the advancement of the theory and practise of photography.

1884. Tobias Robert Thalén, spectroscopic researches.

1886. Samuel Pierpont Langley, researches on the spectrum by means of the bolometer.

1888. Pietro Tacchini, important and long-continued investigations which have largely advanced our knowledge of the physics of the sun.

1890. Heinrich Hertz, work on electro-magnetic radiation.

1892. Nils Christofer Dunér, astronomical observations.

1894. James Dewar, researches at very high and very low temperatures, and on spectroscopic phenomena.

1896. Philipp Lenard and Wilhelm Konrad Röntgen, researches on phenomena which occur outside a highly exhausted tube through which an electrical discharge is passing.

1898. Oliver Joseph Lodge, researches on radiation and on the relations between matter and ether.

1900. Antoine Henri Becquerel, discoveries in radiation proceeding from uranium.

1902. Charles Algernon Parsons, application of the steam turbine to industrial purposes and its recent extension to navigation.

1904. Ernest Rutherford, researches on radioactivity, and particularly his discovery of the existence and properties of the gaseous emanations from radio-active bodies.

The following is a list of grants made from the income of the Rumford Fund of the American Academy in furtherance of research. In a few cases the appropriation has not been called for because the research in question has not proved feasible, because funds have been provided from elsewhere, or for other reasons. When this is believed to be the case it is so stated.

GRANTS FROM THE RUMFORD FUND.

1832–1862. Observatory at Cambridge, for telescope and other apparatus........	$3,776
Enoth Hale. For rain gauges and sundry expenses for experiments and investigations relating to the fall of rain	1,697
1862. Philander Shaw. Experiments relating to air engines................	600
1863. Ogden N. Rood. Physical relations of iodized plate to light. (Appropriation subsequently transferred to another research, viz., photometry.)....	300
1864. Wolcott Gibbs. For purchase of a Meyerstein spectrometer and Regnault's apparatus for measuring vapor-tension	600
Josiah P. Cooke, Jr. For purchase of glass prisms to be used in an investigation of metallic spectra. (These prisms were purchased from the academy by Professor Cooke in 1871.)....	200
1866. Ogden N. Rood. Photometry. (Appropriation of 1863 for relations of	

iodized plate to light, $300, transferred to this purpose.)

1867. Wolcott Gibbs. For repairing Meyerstein spectrometer belonging to the academy 100

1869. Joseph Winlock. For purchase of spectroscopic instruments for observations of the solar eclipse of August, 1869 300

1870. Benjamin Apthorp Gould. For photometric and spectroscopic apparatus for the observatory at Cordova. (Apparatus subsequently purchased by the Argentine government.).......... 500

1875. John Trowbridge. Improvement of magneto-electric machine and induction coil 500

1876. Henry A. Rowland. New determination of mechanical equivalent of heat. 600

Samuel P. Langley. Researches on radiant energy 600

1877. Benjamin O. Peirce, Jr. Investigation of the conduction of heat in the interior of bodies. ($60, only, called for.) 200

Edward C. Pickering. Atmospheric refraction 520

1878. Wolcott Gibbs, John Trowbridge, Edward C. Pickering. Experiments on photometry and polarimetry. (A small portion only of this appropriation was called for.) 500

Charles A. Young. In aid of observations on solar eclipse of July 29, 1878. (Appropriation not called for.) 300

Nathaniel S. Shaler. Investigation on loss of internal heat of earth in the neighborhood of Boston. (Appropriation not called for.) 200

William W. Jacques. Experiments on the distribution of heat in the spectrum 100

Wolcott Gibbs, Edward C. Pickering, John Trowbridge. Determination of indices of refraction. (A small portion only of this appropriation was called for.) 500

1879. John Trowbridge. Heat developed by magnetization and demagnetization of magnetic metals.................. 200

William W. Jacques. Radiation at high temperatures 200

William A. Rogers. To procure a metric standard of length.................. 350

1880. Silas W. Holman. Viscosity of gases 250

Wolcott Gibbs. Construction of dynamo-electric machine of a new plan........ 150

Samuel P. Langley. Distribution of heat in diffraction spectrum......... 300

1882. Edward C. Pickering. Stellar photography, with a view of obtaining a method of estimating the brightness of stars 500

John Trowbridge. Thomson effect and allied subjects 250

1883. John Trowbridge. Addition to last preceding appropriation 100

Frank N. Cole. Experiments on Maxwell's theory of light............... 50

1884. Rumford Committee. For purchase of Rowland grating.................. 40

William H. Pickering. Experiments in photography 200

John Trowbridge, Edward C. Pickering, Charles R. Cross. Experiments on standard of light.................... 300

Edward C. Pickering. Photometry..... 200

William A. Rogers. Production of constant temperatures 100

John Trowbridge. Effect of changes of temperature on magnetism........... 100

1885. William A. Rogers. For construction of constant temperature room. (Addition to former appropriation.).. 82

Edward C. Pickering. Photometry..... 300

William H. Pickering. Photography and new standard of light.............. 300

1886. William H. Pickering. Observations of solar corona, eclipse of August, 1886 500

Henry P. Bowditch. Calorimetric observations on the heat of the human body. ($100, only, called for.) 500

John Trowbridge. Standard of light. (Appropriation subsequently transferred to another research, viz., radiant energy.) 250

Charles R. Cross. Thermo-electric effect in Munich shunt method. (Appropriation not called for.) 75

1887. John Trowbridge. Investigations on radiant energy. (Appropriation of 1886 for standard of light, $250, transferred to this purpose.)

Charles R. Cross and Silas W. Holman. Thermometry 250

Erasmus D. Leavitt, Jr. Investigations upon a pyrometer. (Appropriation not called for.) 250

John Trowbridge. Metallic spectra..... 250

1888. John Trowbridge. Metallic spectra. (Addition to former appropriation.) . 500

William H. Pickering. For observations on solar eclipse of January, 1889..... 500

1889. Charles C. Hutchins. Investigation on lunar radiation.................. 250

Edwin H. Hall. Heat development in cylinder of steam-engine............. 100

Henry A. Rowland. Metallic spectra... 500

1890. Edwin H. Hall. Investigations on cylinder temperature 100

Benjamin O. Peirce. Temperature changes in interior of solids. (Appropriation not called for.).......... 200

1892. Daniel W. Shea. Velocity of light in magnetic field.................... 250

Benjamin O. Peirce. Propagation of heat within certain solid bodies........... 200

Henry A. Rowland. Investigations on solar spectrum 250

1893. William A. Rogers. Investigation on the pulsation of thermometers..... 175

William H. Pickering. Observations in Arizona on transparency and steadiness of the air and on the changes in temperature on the planet Mars. (Appropriation not called for.).......... 500

1894. Frank A. Laws. Thermal conductivity of metals.................... 300

Edward L. Nichols. Radiation from carbon at different temperatures......... 250

1895. Edwin H. Hall. Thermal conductivity of metals.................... 250

Arthur G. Webster. Velocity of electric waves 250

Benjamin O. Peirce. Thermal conductivities of poor conductors........... 250

1896. Henry Crew. Electric, chemical and thermal effects of electric arc........ 400

Robert O. King. Thomson effect in metals 100

1897. Arthur G. Webster. Velocity of light. (Appropriation not called for.) 500

George E. Hale. Construction of spectroheliograph 400

Arthur G. Webster. Construction of revolving mirror 250

Arthur G. Webster and Robert R. Tatnall. The Zeeman effect.................. 100

1898. Wallace C. Sabine. Researches on ultra-violet radiation 400

Albert A. Michelson. New form of diffraction grating. (Echelon spectroscope.) 500

Theodore W. Richards. For the construction of a microkinetoscope, to be applied to a study of the birth and growth of crystals................. 200

1899. Wallace C. Sabine. Further researches on ultra-violet wave-length.. 200

Henry Crew. Spectrum of the electric arc 200

Arthur G. Webster. Distribution of energy in various spectra studied by means of the Michelson interferometer and the radiometer. (Appropriation not called for.)................... 200

Edwin B. Frost. To aid in construction of a spectrograph especially designed for the measurement of stellar velocities in the line of sight............ 500

1900. Edward C. Pickering. For constructing a new type of photometer to be used in an investigation on the brightness of faint stars, to be carried out by cooperation with certain observatories possessing large telescopes... 500

Theodore W. Richards. Transition temperatures of crystallized salts........ 100

Arthur L. Clark. Molecular properties of vapors in the neighborhood of the critical point 250

Charles E. Mendenhall. Investigations on a hollow bolometer. ($100, only, called for.) 200

George E. Hale. Application of the radiometer to the study of the infrared spectrum of the chromosphere.... 500

Arthur A. Noyes. Effect of high temperatures on the electrical conductivity of salt solutions.................. 300

1901. Theodore W. Richards. Research on the expansion of gases.............. 500

Henry Crew. Order of appearance of the different lines of the spark spectrum.. 100

Robert W. Wood. Anomalous dispersion of sodium vapor 350

Arthur G. Webster. For purchase of fluorite plates 65

1902. Ernest F. Nichols. For the purchase of a spectrometer, in furtherance of a research on resonance in connection with heat radiations................ 300

Theodore W. Richards. For the construction of a mercurial compression pump to be used in a research on the Joule-Thomson effect. (Appropriation subsequently transferred to another re-

search, viz., the experimental study of chemical thermodynamics.) 750

Arthur A. Noyes. Effect of high temperatures on the electrical conductivity of aqueous solutions................ 300

Ralph S. Minor. Dispersion and absorption of substances for ultra-violet radiation 150

1903. Theodore W. Richards. The experimental study of chemical thermodynamics. (Appropriation of 1902 for compression pump, $750, transferred to this purpose.)

Sidney D. Townley. For the construction of a stellar photometer.......... 100

Edwin B. Frost. For the construction of a special lens for use in connection with the stellar spectrograph of the Yerkes Observatory for the study of radial velocities of faint stars....... 200

Ernest F. Nichols and Gordon F. Hull. In aid of the investigation of the relative motion of the earth and the ether by the method of 'Fizeau's polarization experiment.' (Appropriation transferred to another research, viz., effect of motion of earth on intensity of radiation.)...................... 250

George E. Hale. For the purchase of a Rowland concave diffraction grating to be used in the photographic study of the brighter stars................... 300

Edward C. Pickering. For the construction of two stellar photometers to be placed at the disposal of the Rumford committee 150

Ernest F. Nichols and Gordon F. Hull. Effect of the motion of the earth on the intensity of radiation. (Appropriation for Fizeau's polarization experiment, $250, transferred to this purpose.)

Frederic L. Bishop. Thermal conductivity of lead....................... 75

Frederick A. Saunders. Characteristics of spectra produced under varying conditions 200

William J. Humphreys. Shift of spectrum lines due to pressure........... 300

Norton A. Kent. Circuit conditions influencing electric spark lines......... 250

Edward W. Morley. Nature and effects of ether drift 500

1904. John A. Dunne. Fluctuations in solar activity as evinced by changes in the difference between maximum and mimimum temperatures 200

Carl Barus. Optical method of study of radioactively produced condensation nuclei. (Appropriation not yet called for.) 200

DeWitt B. Brace. Double refraction in gases in an electrical field........... 200

Robert W. Wood. Optical and other physical properties of sodium vapor.. 350

Norton A. Kent (addition to former appropriation). Circuit conditions influencing electric spark lines........ 100

Arthur L. Clark (addition to former appropriation). Molecular properties of vapors in the neighborhood of the critical point 150

1905. DeWitt B. Brace (addition to former appropriation). Double refraction in gases in an electrical field........... 200

Charles B. Thwing. Thermo-electric force of metals and alloys........... 150

Harry W. Morse. Fluorescence......... 500

John Trowbridge. Electric double refraction of light....................... 200

Edwin H. Hall. Thermal and thermoelectric properties of iron and other metals 200

The Rumford Committee will at any time receive applications for aid from the Rumford Fund in furtherance of researches in heat or light. Such applications may be sent to the chairman of the committee or to any of its members in care of the American Academy of Arts and Sciences, Boston, Mass. Full statements should be made as to the object of the investigation for which aid is asked. A report of work is expected yearly as to the progress of the research for which a grant has been made. All apparatus purchased from appropriations from the Rumford Fund is the property of the academy and is to be returned to it when the research in question is completed.

The rule as to publication of papers embodying the results of investigations furthered by grants from the fund is indicated in a vote of the Rumford Committee, passed June 8, 1898.

EXTRACT FROM THE RECORDS OF THE RUMFORD COMMITTEE.

It was voted that in the judgment of the committee, persons carrying on researches with the aid of the Rumford fund should submit to the academy an account of their researches not less complete than that published elsewhere. These researches may be published in any place or form, with the proviso that due recognition be made of the grant, and of the presentation of the paper to the academy.

SCIENTIFIC BOOKS.

THE INTERNATIONAL CODE OF ZOOLOGICAL NOMENCLATURE AS APPLIED TO MEDICINE.

As Bulletin No. 24 of the Hygienic Laboratory of the Public Health and Marine Service of the United States, Dr. Charles Wardell Stiles has reprinted the English text of the recently adopted 'International Code of Zoological Nomenclature, with remarks and a discussion of its application to animals concerned in medical pathology.

This code was drawn up after several preliminary meetings and discussions at the fifth International Zoological Congress at Berlin (1901) and was adopted in printed form at the sixth congress at Berne (1904).

It is based on a number of earlier codes, the 'Stricklandian Code' (1842–3), the 'Dall Code' (1877) and the 'Code of the American Ornithologists Union' (1885), being historically among the most important of these. The present code is the work of a commission composed of Raphael Blanchard, of Paris; J. V. Carus, of Leipzig; F. A. Jentink, of Leyden; P. L. Slater, of London, and C. W. Stiles, of Washington. The final editors were Blanchard, von Maerenthal and Stiles.

At Berne, a larger permanent commission was organized, so constituted that five members retire every three years, and the present membership is as follows: Retiring in 1907, R. Horst, of Leyden; J. A. Jentink, of Leyden; D. S. Jordan, of Stanford; F. E. Schulze, of Berlin, and L. Stejneger, of Washington. In 1910, R. Blanchard, of Paris; L. Joubin, of Paris; C. W. Stiles, of Washington; Th. Studer, of Berne, and R. R. Wright, of Toronto. In 1913, Ph. Dautzenberg, of Paris; W. E. Hoyle, of Manchester; L. von Graff, of Graz; F. C. von Maerenthal, of Berlin, and H. L. Osborn, of Columbia. This broad representation among men of various nations and specialties engaged in common problems should go far toward securing acceptance of the rules adapted—though the final test must be their actual fitness to the purpose for which they are adapted.

In 1886, Ludwig estimated the number of known species of animals at 312,015. Since that time, nearly half as many more have been added, and the actual number of species of insects alone, known and unknown, is estimated by Dr. L. O. Howard at nearly 4,000,000.

About 120,000 generic names have been applied to animals, and the number increases at the rate of about 1,150 per year. As much of the world is still virtually unexplored, Dr. Stiles concludes:

> The known genera and species of animals represent but a fraction (but ten to twenty per cent.) of the zoological names which will come into use during the next two or three centuries. It is clear that our nomenclatural tasks are easy, compared with the tremendous number of technical names the future generations will fall heir to. Under these circumstances, it is seen that in order to prevent our science from becoming 'a mere chaos of words,' every zoological author owes a serious nomenclatural duty, not only to himself and his colleagues of to-day but also to future generations of zoologists. If it were left to each author to accept or reject names according to his own personal wishes in the matter, the science of zoology would soon reach a stage in which it would be difficult for one author to understand the writings of another, hence in order to prevent such a chaotic state, systematists have felt themselves forced to adopt certain rigid rules in accordance with which any given animal has only one valid name, and that name shall be valid not only in the country in which it is proposed, but in all other lands as well.

The insistence on exactness in nomenclature is as important to the worker in systematic zoology or in geological distribution, as cleanness and sharpness of scalpel to the anatomist. No one failing to consider carefully his obligations in these regards, ever did first class work in the fields in question.

If there were only a few animals concerned,

we might give way to our tastes or prejudices in the choice of names. Most of us would rather say *Amphioxus* than *Branchiostoma, Pterichthys* than *Pterichthyodes, Lucioperca* than *Stizostedion*. But if we transgress our rules and use the later name or the preoccupied name in these familiar examples, we have no case against the man who follows his own whims throughout the series. We must either use the oldest names throughout, or else let anybody call anything what he pleases. This means absolute chaos in all lines of study where nomenclature is required.

The present code seems in all respects admirable. It covers the ground more fully than any other. In other words, it eliminates more successfully all the elements of whim, taste or individual preference. It is well to have names euphonious, descriptive and correctly formed. It is almost infinitely more important to have them stable, and there is no other way to stability save the rigid enforcement of rules which find their origin in the conditions of science itself.

In this code, zoological nomenclature is regarded as separate from botanical, though parallel with it. The law of priority is held paramount and nomenclature dates from 1758, the tenth edition of the 'Systema Naturæ' of Linnæus. No name is to be changed because of incorrect spelling or formation, nor rejected on account of inappropriateness. Generic names spelled differently are held to be distinct names, for a name is known by its spelling. Tautonomy (*Anguilla anguilla* and the like) is permitted. 'Once a synonym always a synonym' is a maxim adopted with an exact definition.

Some parts of the code are not sufficiently full. For example, the status of generic names of non-binomial authors subsequent to Linnæus is not clearly stated. Thus in 1763, Gronow published a number of genera of fishes, the species under each being given in polynomials. In other words, he recognized genera but did not adopt the binary system of Linnæus. The code does not leave it clear whether these post-Linnæan non-binominal genera should be adopted.

Mr. Stejneger (in letter, February 25, 1905) states that it was the judgment of the commission that the genera of non-binomial authors, dating after 1758, should be admitted. In the Code (Article 2) it states that 'the scientific designation of animals is uninomial for subgenera and all higher groups.' According to Stejneger, 'The rule applied to the generic term would be that the valid name of a genus can be only that name by which it was first designated on the condition that the author has *applied* the principles of the international rules by using a nominal designation.'

Under this ruling:

> Brisson and the others (Gronow, etc.) have applied the principle in question so *far as generic names are concerned*, and their generic names are, therefore, valid, while their binominals or trinominals are not valid though they may appear (accidentally) like true specific or subspecific names. The mononomials are true generic names and must stand as such.

Another class of names claiming priority is not touched at all by this code. Klein (about 1744) defined a large number of genera of fishes. In a post-Linnæan compilation of Walbaum ('Artedi Piscium,' 1792), the diagnoses of all these pre-Linnæan genera are reprinted, although without formal adoption into the binomial system. These genera are mononomially defined, at a later date than 1758, and there is no doubt as to the species intended to be included in them. If these names had been original with Walbaum, they would be accepted without question. What is their status as reprints in a compilation?

The article (30) fixing the type of a composite genus is inadequate, and gives evidence of compromise among conflicting views. It is here that much of the present trouble in zoological nomenclature arises. The paragraph in question reads:

> If the original type of a genus was not indicated, the author who first subdivides the group may apply the name of the original genus to such restricted genus or subgenus as may be judged advisable, and such assignment is not subject to subsequent change.

This looks simple, but in practise it needs further definition. Many revisers have restricted the old genus to species with which

they are not themselves concerned. The type should be the best known species from the standpoint of the author. Frequently the first reviser (as of *Esox* and *Syngnathus*) selects as type a species which was by no means central or typical in the estimation of the original author. Still more frequently it is impossible to tell who is the first reviser, unless that phrase itself receive accurate definition. In the early days, many authors paid little attention to earlier genera, and in their reviews they encroached on the groups named by their predecessors, without limiting them or fixing their species. If the phrase is retained, the first reviser should be the one who first consciously limited the range of the genus by fixing the actual name to one of the actual original species. This at least is tangible. When a type is not fixed either by the original author or by his 'first reviser,' the code makes certain recommendations to the systematist. These seem to be of the nature of advice, and are void and of no effect when a type has been previously fixed. Third among these comes the method of elimination, a plausible process, but one which has never been defined and which in complex cases leads to as many different results as there are writers who attempt to use it.

In the code, these recommendations are made subordinate to the rule of the 'first reviser.' It is a question, however, whether the first and second of these recommendations (using as type the species suggesting the generic name as *Lutianus lutianus*, and using the one personally best known to the original author, as *Esox lucius*) should not have had precedence over 'the first reviser rule.' The present writer finds difficulty as above stated with the rule of the first reviser. In fishes, he finds the method of elimination practically worthless, at least, unless some rigid definition of it can be agreed upon. The arbitrary choice as type of the first species named under each new genus by its describer, is a rule which could have been enforced without confusion and which yet may be found necessary. It is, perhaps, too late now to go back to it, although several of the chief writers on fishes, Bleeker and practically Lacépède and Cuvier have more or less consistently adopted it. It is at least fair to apply this rule to these particular authors and to others who begin their account of each genus with the 'type' or 'chef de file.'

A great deal can be said in favor of a principle in nomenclature, which may be stated as follows: The determination of the significance of each name, generic or specific, must be made on evidence furnished by the author framing the name or on evidence existing at the time. It is possible to give an exact type to every genus or species on this basis, or in default of this to follow the simple and just rule of page precedence. This gives fixedness at least, and we need demand nothing else. This method would release zoology from the unwelcome and profitless task of finding out what an author means, by studying the effect of his words on his successors. In other words, our studies in this line would be limited to the author himself and to those on whom he may have relied. The adoption of the rule that a specific name might be identical with the name of a genus has saved us, in the aggregate, years of investigation among useless and forgotten synonyms. This same kind of study is forced upon us by the rule of the first reviser or the still more complex custom of the application of the method of elimination.

Dr. Stiles evidently appreciates the incompleteness of article 30, for he supplements it by twelve rules of his own, saying that 'No existing code of nomenclature provides for all cases that arise, so that authors make supplemental rules for themselves.' But these supplemental rules are necessarily parts of a completed code. The final form of this code should, therefore, contain or replace these twelve excellent rules of Dr. Stiles. Till this is done, we may recommend that these supplementary rules be favorably regarded by naturalists, though in our judgment page-precedence—as a remedy for taste or whim—will ultimately be given a place higher up the line than that assigned by Dr. Stiles, and 'absolute tautonomy,' 'virtual tautonomy' and the Linnæan rule of using 'the best known European or officinal species' as type

will take precedence over the fixing of the type by the first reviser.

In the present bulletin, besides the original text of the International Code, Dr. Stiles gives pertinent discussions and illustrations, for the purpose of making plain the reasons for the rules adopted. He gives also a valuable discussion of the proper application of various names used in medicine as applied to animal or bacterial parasites. Among these names are *Tænia, Echinococcus, Bacterium, Spirillum, Spirodiscus, Bacillus, Dipylidium, Dibothriocephalus* and *Monas*.

In conclusion we must congratulate Dr. Stiles for this most useful bulletin, which should be in the hands of every worker in systematic zoology, and most botanists would gain from its perusal.

DAVID STARR JORDAN.

Handbuch der Geographischen Ortsbestimmung für Geographen und Forschungsreisende. Von Dr. ADOLPH MARCUSE, Privatdozent an der Universität Berlin. Braunschweig, Friederich Vieweg und Sohn. 1905. 8vo. Pp. 341; 55 illustrations.

The author has produced a useful and interesting book which, according to the preface, is intended primarily for the guidance of geographers and explorers, but incidentally also for teachers and students. Having in mind the needs of the latter, he has included in his manual many subjects by way of explanation or suggestion which would not be considered necessary in a work intended solely as a guide for the determination of positions with a degree of accuracy commonly considered sufficient for geographical purposes. Thus five pages are devoted to an exposition of the state of our knowledge of the variation of latitude. By way of suggestion he refers to the application of photography to the determination of geographical positions, promising the publication of a manual of the photographic method on the completion of certain experimental work which he apparently has in hand, and which must have made very satisfactory progress, to judge from his remark on page 250 to the effect that longitude can readily be determined by means of a portable photographic universal instrument to within one second of time. He also holds out the promise of success of some longitude work undertaken by Dr. Albrecht by means of wireless telegraphy. In this connection, it may be remarked parenthetically that the coast survey as early as 1901 obtained a satisfactory graphic record of wireless time signals sent to the Nantucket Station from the light ship for the purpose of testing the method of wireless longitude.

The requirements of the future are forestalled in an appendix on the determination of geographic positions by æronauts. He describes a quadrant which was actually used during a balloon voyage and gives an example of the results obtained. In connection with the use of Sumner's method by æronauts the author calls attention to the advantages of the use of 'Mercator's functions,' a name proposed by Börgen, who elaborated the new method of computation and published his formulæ and tables in the *Archiv der Deutschen Seewarte* (1898). On account of its simplicity and the avoidance of the usual logarithmic tables of the six circular functions, the new method is to be highly commended to navigators for whom it was devised. These references to Marcuse's book will be sufficient to indicate that it is by no means a mere rearrangement of old formulæ and methods.

The first chapter gives an explanation of celestial and terrestrial coordinates and of the variations to which they are subject. The second contains a very useful description of the Ephemerides published by various governments and evaluates their usefulness for different purposes. It gives descriptive and explanatory references to tables designed to facilitate computations, to star maps and celestial globes, etc.

The third chapter, which is devoted to instruments, gives a clear and very useful account of chronometers and their use. The author does not attempt to describe all known forms of instruments which might be used. Sextants and reflecting instruments he leaves to books on navigation. He recommends the use of the portable universal as the standard instrument which meets all requirements and

confines his descriptions to that form with the exception of a particular quadrant already referred to.

The fourth chapter treats of the methods which can be used most advantageously for determining time, latitude, longitude and azimuth.

The appendix, which, as already stated, gives attention to geographic determinations in the air, contains also a description with illustrative examples, of methods for determining time, latitude and azimuth without the use of graduated circles, methods for the application of which only a watch and a spool of thread are necessary auxiliaries.

The reader will be attracted by the beautiful typography and the excellence of the illustrations which enhance the value of the book.

O. H. T.

SCIENTIFIC JOURNALS AND ARTICLES.

THE opening (October) number of volume 12 of the *Bulletin of the American Mathematical Society* contains the following articles: 'The Elementary Treatment of Conics by Means of the Regulus,' by Charlotte Angas Scott; 'Arzela's Condition for the Continuity of a Function Defined by a Series of Continuous Functions,' by E. J. Townsend; 'Galois Field Tables for $p^n \leqq 169$,' by W. H. Bussey; Notes; New Publications.

The November number of the *Bulletin* contains: 'Report of the Twelfth Summer Meeting of the American Mathematical Society,' by F. N. Cole; 'A Set of Generators for Ternary Linear Groups,' by Ida May Schottenfels; 'Note on the Structure of Hypercomplex Number Systems,' by Saul Epsteen; 'A Geometric Property of the Trajectories of Dynamics,' by Edward Kasner; 'On the Possible Numbers of Operators of Order 2 in a Group of Order 2^m,' by G. A. Miller; 'On the Arithmetic Nature of the Coefficients in Groups of Finite Monomial Linear Substitutions,' by W. A. Manning; 'A Modern Calculus of Variations' (Review of Bolza's Lectures on the Calculus of Variations), by E. R. Hedrick; 'Two Books on Analytic Geometry' (Review of Smith and Gale's Elements of Analytic Geometry and Introduction to Analytic Geometry), by O. D. Kellogg; Notes; New Publications.

The American Naturalist for September contains the following articles: 'Interrelationships of the Sporozoa,' by Howard Crawley, which opens with an excellent statement of the lines along which these animals have developed, and concludes that the term sporozoa should be used as a temporary and convenient cloak to cover certain protozoa. A 'Contribution to Our Knowledge of the Myxinoids,' by Julia Worthington, contains a large amount of interesting information, based on the Californian *Bdellostoma dombeyi*, concerning these little-known 'fishes.' F. C. Baker contributes 'Notes on the Genitalia of *Lymnea*.'

Bird Lore for September–October has three excellent illustrated papers, telling how to attract and preserve the winter birds. 'Our Avian Creditors,' by Ernest H. Baynes; 'The Winter Feeding of Birds,' by Mabel Osgood Wright, and 'How to Attract the Winter Birds,' by Edward H. Forbush. W. W. Cooke presents the twelfth paper on 'The Migration of Warblers' and there are 'Notes on Winter Feeding' by a number of contributors. Under the Audubon Societies is an appeal for funds for the widow of Game Warden Bradley and for the prosecution of his murderer, which it is hoped may meet with a ready response.

The Museums Journal of Great Britain has a frontispiece and brief article on the Central Section of the Museum of the Brooklyn Institute and an account of 'A Papier-maché Model of the Monk-fish.' The appointment of A. B. Skinner as director of the Albert and Victoria Museum is announced, he taking the place vacated by Sir C. Purdon Clarke. Mr. George Murray has resigned his position of keeper of the department of botany in the British Museum, a place he has held for the last ten years.

THREE good papers appear as separates from the report of the Commissioner of Fisheries for 1903–1904: 'A Revision of the Cave Fishes of North America,' by Ulysses O. Cox; 'The Life History of the Blue Crab,' by W. P. Hay, and 'The Crab Industry of Maryland,' by Winthrop A. Roberts.

The Report of the Manchester Museum for 1904–1905 notes a deficiency in the finances of about $1,000, but causes one to wonder how so much good work as is accomplished by this institution can be done on an income of less than $15,000.

DISCUSSION AND CORRESPONDENCE.

CONTRIBUTIONS TO OUR KNOWLEDGE OF THE AERATION OF SOILS.

Under the above title Dr. Edgar Buckingham presents the results of a series of investigations relating to an important subject, in Bulletin No. 25 of the Bureau of Soils. As a practical problem in soil management the securing of those conditions which will insure a deep and ample ventilation is extremely needful; and hence any essential advance in our knowledge of the principles governing soil aeration is important. In the letter of submittal it is stated:

This paper presents for the first time definite information regarding the rate at which a gas escapes by diffusion from the soil into the atmosphere, or *vice versa*. It shows that the rate of diffusion varies approximately as the square of the porosity of the soil, and that this diffusion follows the laws for the free diffusion of gases. It thus becomes possible to calculate the rate of aeration in any particular soil from results obtained in experiments on free diffusion. Tables are given showing the rate of escape (and consequently, for a condition of equilibrium, the rate of formation as well) of carbon dioxide in the soil when the porosity of the soil and the concentration of the carbon dioxide at any given depth are known. The paper shows further that the aeration of soils is almost entirely due to diffusion phenomena changes in barometric pressure having very little influence in comparison.

The author in his 'Concluding Remarks' says:

1. We have measured the rate of flow of air under pressure by transpiration and of air and carbonic acid by diffusion, through four widely different soils, in varying states of structure, compactness and moisture content.

2. We have shown that the speed of diffusion of air and carbonic acid through these soils was not greatly dependent upon texture and structure, but was determined in the main by the porosity of the soil.

3. We have shown that the rate of diffusion was approximately proportional to the square of the porosity.

4. We have shown that when this relation is used to compute from our results the rate of free diffusion when no soil is present, it gives a result which is entirely consistent with what is already known from the work of other experimenters on the free diffusion of gases.

5. We have shown that when the porosity of a soil is reduced by compacting it, the ease with which air flows through it under the driving influence of a difference of pressure is greatly reduced, varying as the sixth or seventh power of the porosity.

6. We have investigated the depths to which free outside air might penetrate soils to different depths, under such barometric variations as are to be expected in average cases, if the outside air remained distinct from the soil air.

7. We have shown how to compute the rate of escape of carbonic acid from the soil by diffusion under given conditions of pressure, temperature, porosity and concentration of carbonic acid.

8. We have compared the linear velocities of diffusion and barometric transpiration, and hence—

9. We have shown that the escape of carbonic acid from the soil and its replacement by oxygen take place by diffusion and are determined by the conditions which affect diffusion, and are sensibly independent of the variations of the outside barometric pressure.

The foregoing remarks and conclusions are based on the mathematical treatment of a very limited series of laboratory experiments, which, however, have been executed with great care. The subject is one so complex and intricate that it can not be solved by so short and direct a cut and it is a matter for exceeding regret that this piece of work, admirable in itself so far as it goes, should be given out by the Department of Agriculture with so much of assurance of finality for its conclusions before they have been checked by even a single field observation or experiment. Almost infinite injury is done to the cause of agricultural science and to the growth of the Department of Agriculture along sound and enduring lines by prematurely exploiting results of investigation, striving to get them before the public eye of practical men—congressmen, farmers, merchants and manufacturers—but

succeeding in getting them there in the form of untruths, or of partial truths which lead to errors of practice so soon as they are applied. Lamentable examples of these are furnished in 'Bulletin 22' and in the extended press promulgation regarding what may be expected through bacterial inoculation of the soil. Much expense was incurred in conducting the investigations referred to and in getting them before the public; very much more is being incurred by those who are giving them practical trial; but by far the greatest expense will accrue during the time required to outgrow the disappointment and the smart of defeat, of wasted effort. It is this condition of things, more than ignorance and more than conservatism, which maintains with terrible effectiveness, as a brake on agricultural progress, the dogma, 'Book farming don't pay.'

In calling attention to the results of the author's investigations it is important to point out that rates of transpiration, as measured in the laboratory trials, are quite inapplicable for use in giving a measure of the rate of flow of air through soils under field conditions. It must be noted that in preparing the soils for the measurements of rates of transpiration they were 'first broken up fine in a mill.' This condition is very wide from what is found in the field and represents more nearly a puddled soil which is always a condition of sterility, and we believe that one of the chief causes of this sterility is the inadequate aeration possible under such conditions. In considering the results of the author therefore it must be borne in mind that he has measured the rates of transpiration—and of diffusion also—through a thin layer whose field structure had previously been altered by what may be designated dry-puddling. In illustration of the effect of dry-puddling we shall cite two series of observations made by Mr. Nelson and Mr. Hogenson, under our direction, while connected with the Bureau of Soils. They are taken from the records in the office of the bureau, which contain several hundreds of measurements covering many types of soil which have been examined as to the rates of transpiration in the first, second, third and fourth feet. In the particular cases cited we select two of the soils which were under investigation in 1903 upon which corn and potatoes were grown, as reported in Bulletin 26 of the Bureau of Soils. The rates of transpiration through these soils were measured under five different conditions, as indicated in the table. By 'field condition' is to be understood the granulation into which the soil falls naturally when plowed in good condition of moisture, but using only such portions of it as readily pass a one millimeter screen in the air dry condition and without rubbing. This soil was firmly packed in the transpiration tube and the rate of flow of air through it measured, after which it was returned to a mortar and pulverized by gently working it under a rubber pestle. When in this condition the transpiration was again measured, after which it was pestled a second time, the process being repeated until the rates of transpiration were obtained for the five different conditions.

MEAN RELATIVE RATES OF FLOW OF AIR THROUGH AIR DRY SOILS MORE OR LESS FINELY PULVERIZED.

	Norfolk Sandy Soil.		Janesville Loam.	
	Pore Space.	Seconds.	Pore Space.	Seconds.
Field condition,	37.0	69	51.6	83
Pestled once,	31.8	1,050	48.5	600
Pestled twice,	29.9	1,724	48.5	800
Pestled three times,	29.1	2,025	47.9	1,200
Pestled four times,	28.5	2,550	46.8	1,350

It is clear from this table that a very profound change in the permeability of the two soils has been effected by the dry-puddling; the rate of flow of air through the Norfolk sand being finally reduced to only about one fortieth of what it was at first, and that of the Janesville loam to about one seventeenth. It will be observed also, if computations are made, that the rates have not varied as the sixth or seventh power of the porosity.

Under undisturbed field conditions the rate of transpiration would in all probability be very different from what is given in the first line of the table and for the surface foot; in air dry condition it is quite certain to be larger than there found. In actual field conditions the body of the soil is ramified by channels and passageways which are often larger than capillary and through which the air moves

more nearly in accordance with the laws controlling the flow through pipes. These passageways often cross-divide the soil itself into endlessly irregular and varying blocks, so that even deep in the ground both air and water flow in more or less open channels, percolation and transpiration taking place into these so that much of the mass movement of either air or water may occur without passing through capillary spaces. We have called attention to this fact in 'Movements of Ground Water'[1] and have there shown how far computations based upon laboratory trials may be from what occurs under natural conditions. These remarks apply with especial force to the surface one to four feet of field soils, the movements through which are of greatest agricultural importance. In this zone shrinkage cracks and passageways left by the decay of roots or formed by burrowing animals, it appears to the writer, influence in a very profound way the interchange of air as effected through changes of atmospheric pressure and cause the estimate of the author to be, in our judgment, very much below the true value.

The particular mode of action of atmospheric pressure which, it appears to us, must be most potent in causing an interchange of air in the surface soil has not been considered in the Bulletin under review. We refer to the pressure and suctional effects which result from, or are associated with, changes in wind velocity and the turbulency of the air movement at the earth's surface. The fluctuations of pressure to which we refer are of too short duration to be recorded by ordinary barographs, but they are nevertheless of sufficient length to be transmitted into the soil and their magnitude often exceeds some of those which the author has considered, while their frequency is very great. The agency which it appears to us is likely to be found most influential in the aeration of the surface soil is the wind itself, as it is the chief factor which effects a change of air in a house. As the air passes over the surface of a field, there must be maintained an excess of pressure on the windward side of obstructions to flow large and small of whatever kind, while on the leeward side there will be maintained a deficiency of pressure, so that on the whole air will be flowing into the soil in some places, traveling more or less horizontally and then rising to come out at places where the air pressure is less. And we do not see how it is possible that this influence can be limited to so small a depth as the author estimates for barometric 'rinsing.' Besides this, when the wind is blowing strong and is gusty in character there is a turbulency of flow analogous to that which occurs in a stream flowing down a rapid, giving to the air a downward thrust upon the surface, from which it rebounds, driving the air into the soil in some places and sucking it out in others.

But to these statements the author will doubtless reply that the writer is merely naming possible factors and doing so without testing their probable efficiency even mathematically. This is quite true, but both these and his own views can and should be checked by field observations and he is aware that we had begun a series of observations on the composition of soil air collected simultaneously at different depths down to four feet and that a considerable amount of the data so obtained are unpublished among the records of the bureau. He is well aware too that my object in having him called to the bureau was that he might make investigations along exactly the lines presented in the Bulletin, with many others, but to have him do so in conjunction with simultaneous field studies so that each line of work would supplement and check the other and be definitely related to observed crop and soil conditions. My criticism now is that the language of the Bulletin conveys the impression that such laboratory and mathematical treatment as he has presented have been sufficient to solve the method of soil aeration and to give a measure of the rate at which it occurs under field conditions, without making a field check on the results.

In regard to the longer period atmospheric waves, which the author has specifically considered, attention should be called to the fact that these, even when they are as short as

[1] 'Principles and Movements of Ground Water,' XIX. Annual Report, U. S. Geol. Survey, Part II., p. 249.

fifteen or twenty minutes, exert an influence which is great enough to very materially influence the discharge of water into wells, field drains, springs and river channels. It is well known too, in the case of breathing or blowing wells, that there is for days together a continuous flow of air out of and into the ground, the currents being strong enough, in a case which we have personally observed, to rattle loose two-inch planks lying over the well, itself nearly a hundred feet deep and four feet in diameter. In this particular case we were called to examine the well because it was impossible to prevent the suction pipe in the well freezing and bursting during the winter, caused by the large volume of cold air sinking into the well at times of high pressure when the thermometer was very low. The owner informed me that in digging the well, after a depth of eighty feet had been reached, work was stopped for the Christmas holidays and that after taking up the work again the gravel was found frozen so that a pick was necessary to loosen it before beginning digging.

We have observed fluctuations in the discharge of water from tile drains, associated with and apparently caused by changes of barometric pressure, amounting to fifteen per cent., and in the case of a deep well, discharging through a six-inch pipe, where the rate of flow was measured in a reservoir on ten consecutive days, the discharge per minute was found to vary between the wide limits of 15.441 and 13.947 cubic feet per minute,—a variation of fully ten per cent. We have also secured autographic records on the Wisconsin and Fox Rivers and from Lake Mendota which seem to indicate that the general seepage over wide areas changes its rate with changes in barometric pressure to such an extent that when the discharge is collected into channels the differences in depth are measurable, and when we have such changes as these it is difficult to believe that the inflow and outflow of air are not greater than is suggested by the conclusions of this Bulletin.

In regard to the influence of simple diffusion, in effecting soil aeration, it appears to the writer that the author has obtained values which must be much too large for field conditions. In carefully measuring the rates of diffusion, under the conditions of rigid control, which he did, the author has done exactly the right thing; but what is lacking is supporting field checks which are greatly needed in verifying the conclusions reached, particularly when the results are used so precisely as to compute the amount of carbonic acid escaping from a given field surface from the per cent. of carbonic acid found in the soil air at a given distance below the surface, where the porosity of the soil is known. Referring specifically to some of the author's data: If it is true, as indicated on page 39, that carbonic acid was escaping from soil in the flower bed in front of the building of the Bureau of Soils at the time of observation at the rate of .04 of a cubic foot per day and that it was being produced at this rate in the soil below the depth of six inches throughout the growing season—let us assume of 120 days—this would mean a production of carbonic acid, through the oxidizing of organic matter, at the rate of 209,088 cubic feet per acre; and, taking the weight of a cubic foot of carbonic acid at .12323 pounds, there would have been a loss from the soil of 7,026 pounds of carbon per acre. This amount of carbon represents, using an analysis of Hall's, 13,970 pounds of water-free grass per acre, or eight tons of hay containing the usual 15 per cent. of moisture. If we take Ebermayer's observations on the amount of carbonic acid in soil air, extending over a full year, except that August, September and October are not included, as given in the Bulletin, we shall find by the method of the author a still larger loss of carbonic acid. We use for this computation the mean amounts found for the year under the five conditions reported upon. At a depth of 15 centimeters (5.9 inches) the mean amount of carbonic acid found in the soil air was 1.09 per cent., the smallest amount in any single observation being .02 per cent., the next smaller .13 per cent. and the next .27 per cent., while the highest amount found was 4.61 per cent. Taking 120 days, as in the former case, and calculating from the table the amount of carbon carried out of the soil during this

period, expressing it again as dry grass on the basis of Hall's analysis, the amount required would be 27,420 pounds per acre or, expressed as hay containing 15 per cent. water, 15.7 tons. Again, using Ebermayer's determinations for the depth of 70 centimeters (27.6 inches) and 120 days, the computed loss of carbonic acid from the soil below this depth would be represented by that carried by 31,960 pounds of dry grass or 17.3 tons of hay per acre. In speaking of the first instance cited the author says: "We may say, then, that, in this case, carbonic acid is escaping from the soil at the rate of about 0.04 cubic foot per day per square foot and therefore that this was the rate of production of carbonic acid in the soil at this place below the depth of six inches." The amount of carbon thus carried out of the soil, according to the assumption and calculation, would be greater than the amount we have calculated above by whatever was produced in the surface six inches. It is clear, however, that no such losses of carbonic acid, resulting from the decomposition of organic matter, could be maintained year after year, as the amount of organic matter in the root system of a crop is not equal to that produced above ground, at least usually, and the amounts produced above ground are only rarely equal to the amounts computed; indeed they are seldom more than one third of those quantities. It must be concluded, therefore, that the laboratory observations and methods of computation give a rate of diffusion of carbonic acid from the soil of a field much greater than actually occurs as a seasonal average. It should be noted that in getting these enormous losses of carbonic acid from the soil we have included only one third of the year, while Ebermayer's observations show that the amounts present in the soil at all seasons, including even winter, are large.

In view of the relations to which we have called attention it is clear that the generalizations cited require critical field trials to be made, bringing them to suitable tests before they should be accepted with full confidence.

F. H. King.

Madison, Wis.,
September 16, 1905.

THE QUESTION AS TO WHETHER FALCONS WHEN SOARING INTERLOCK THEIR PRIMARY WING FEATHERS.

The observations of Mr. Trowbridge upon the habit of hawks when soaring to overlap their primaries (*i. e.*, on the upper side of the wing) have several times been commented upon adversely. And a well-known ornithologist has objected that this behavior of feathers has not been previously observed, in spite of the voluminous field notes as to the habits of hawks, and that no one has been able to confirm the observation of interlocking feathers. Accordingly, I am led to jot down the following notes in favor of Mr. Trowbridge's results, —for my observations are at first hand and were made, I believe, under quite favorable conditions.

It so happened that we were coming up the narrow canal from Sakai to Matsue in the face of a strong wind, so strong, indeed, that our small steamer labored to make headway against it. At one point we disturbed a kite, *Milvus melanotus*—a very common bird, by the way, along Japanese waterways—which rose slowly in the face of the wind and after making several circles followed the margin of the canal, flying and soaring, almost opposite the boat and making about equal headway. It did not occur to me at the moment that the opportunity was a favorable one for watching the wing feathers (for the bird was sometimes as near as a hundred feet), when my eye was caught by the behavior of the primaries. The hawk was flying low, about the height of the eye, and when the wing passed through the plane of the horizon I could see as the wing flapped that several primaries stood out sharply, finger-like, *dorsal* to the plane of the descending wing. This was so conspicuous, indeed, that it seemed difficult to conclude that these feathers could fold *under* one another when, in face of a strong wind, the wings became passive in soaring. Nevertheless, the distance of the bird was so great that I could not convince myself that the interlocking actually took place; I was only sure that the primaries were bowed, so that in soaring this part of the wing must have

been greatly strengthened by the closely opposed feathers. For several minutes the hawk thus flew alongside of the boat, with quite regular periods of flapping and soaring; then, suddenly shifting its course, it circled out, soaring, passing over my head at a distance of about twenty feet. I could then see plainly that the primaries of one wing (right) were interlocked—the condition of the other wing I had not time to observe.

My conclusion, therefore, is that the interlocking of the primaries of hawks takes place, as Mr. Trowbridge has shown, under the conditions of soaring in the face of a strong wind.

BASHFORD DEAN.

RINKAI JIKENJO, MISAKI-MIURA, JAPAN,
September 3, 1903.

SPECIAL ARTICLES.

THE CHROMOSOMES IN RELATION TO THE DETERMINATION OF SEX IN INSECTS.

MATERIAL procured during the past summer demonstrates with great clearness that the sexes of Hemiptera show constant and characteristic differences in the chromosome groups, which are of such a nature as to leave no doubt that a definite connection of some kind between the chromosomes and the determination of sex exists in these animals. These differences are of two types. In one of these, the cells of the female possess one more chromosome than those of the male; in the other, both sexes possess the same number of chromosomes, but one of the chromosomes in the male is much smaller than the corresponding one in the female (which is in agreement with the observations of Stevens on the beetle *Tenebrio*). These types may conveniently be designated as *A* and *B*, respectively. The essential facts have been determined in three genera of each type, namely, (type *A*) *Protenor belfragei*, *Anasa tristis* and *Alydus pilosulus*, and (type *B*) *Lygæus turcicus*, *Euschistus fissilis* and *Cœnus delius*. The chromosome groups have been examined in the dividing oogonia and ovarian follicle cells of the female and in the dividing spermatogonia and investing cells of the testis in case of the male.

Type *A* includes those forms in which (as has been known since Henking's paper of 1890 on *Pyrrochoris*) the spermatozoa are of two classes, one of which contains one more chromosome (the so-called 'accessory' or heterotropic chromosome) than the other. In this type the somatic number of chromosomes in the female is an even one, while the somatic number in the male is one less (hence an odd number) the actual numbers being in *Protenor* and *Alydus* ♀ 14, ♂ 13, and in *Anasa* ♀ 22, ♂ 21. A study of the chromosome groups in the two sexes brings out the following additional facts. In the cells of the female all the chromosomes may be arranged two by two to form pairs, each consisting of two chromosomes of equal size, as is most obvious in the beautiful chromosome groups of *Protenor*, where the size differences of the chromosomes are very marked. In the male all the chromosomes may be thus symmetrically paired with the exception of one which is without a mate. This chromosome is the 'accessory' or heterotropic one; and it is a consequence of its unpaired character that it passes into only one half of the spermatozoa.

In type *B* all of the spermatozoa contain the same number of chromosomes (half the somatic number in both sexes), but they are, nevertheless, of two classes, one of which contains a large and one a small 'idiochromosome.' Both sexes have the same somatic number of chromosomes (fourteen in the three examples mentioned above), but differ as follows: In the cells of the female (oogonia and follicle-cells) all of the chromosomes may, as in type *A*, be arranged two by two in equal pairs, and a small idiochromosome is not present. In the cells of the male all but two may be thus equally paired. These two are the unequal idiochromosomes, and during the maturation process they are so distributed that the small one passes into one half of the spermatozoa, the large one into the other half.

These facts admit, I believe, of but one interpretation. Since all of the chromosomes in the female (oogonia) may be symmetrically paired, there can be no doubt that synapsis in this sex gives rise to the reduced number of symmetrical bivalents, and that consequently

all of the eggs receive the same number of chromosomes. This number (eleven in *Anasa*, seven in *Protenor* or *Alydus*) is the same as that present in those spermatozoa that contain the 'accessory' chromosome. It is evident that both forms of spermatozoa are functional, and that in type *A* females are produced from eggs fertilized by spermatozoa that contain the 'accessory' chromosome, while males are produced from eggs fertilized by spermatozoa that lack this chromosome (the reverse of the conjecture made by McClung). Thus if n be the somatic number in the female $n/2$ is the number in all of the matured eggs, $n/2$ the number in one half of the spermatozoa (namely, those that contain the 'accessory'), and $n/2 - 1$ the number in the other half. Accordingly:

In fertilization

$$\text{Egg } \frac{n}{2} + \text{spermatozoon } \frac{n}{2} = n \text{ (female).}$$

$$\text{Egg } \frac{n}{2} + \text{spermatozoon } \frac{n}{2} - 1 = n - 1 \text{ (male).}$$

The validity of this interpretation is completely established by the case of *Protenor*, where, as was first shown by Montgomery, the 'accessory' is at every period unmistakably recognizable by its great size. The spermatogonial divisions invariably show but one such large chromosome, while an equal pair of exactly similar chromosomes appear in the oogonial divisions. One of these in the female must have been derived in fertilization from the egg-nucleus, the other (obviously the 'accessory') from the sperm-nucleus. It is evident, therefore, that all of the matured eggs must before fertilization contain a chromosome that is the maternal mate of the 'accessory' of the male, and that females are produced from eggs fertilized by spermatozoa that contain a similar group (*i. e.*, those containing the 'accessory'). The presence of but one large chromosome (the 'accessory') in the somatic nuclei of the male can only mean that males arise from eggs fertilized by spermatozoa that lack such a chromosome, and that the single 'accessory' of the male is derived in fertilization from the egg nucleus.

In type *B* all of the eggs must contain a chromosome corresponding to the large idiochromosome of the male. Upon fertilization by a spermatozoon containing the large idiochromosome a female is produced, while fertilization by a spermatozoon containing the small one produces a male.

The two types distinguished above may readily be reduced to one; for if the small idiochromosome of type *B* be supposed to disappear, the phenomena become identical with those in type *A*. There can be little doubt that such has been the actual origin of the latter type, and that the 'accessory' chromosome was originally a large idiochromosome, its smaller mate having vanished. The unpaired character of the 'accessory' chromosome thus finds a complete explanation, and its behavior loses its apparently anomalous character.

The foregoing facts irresistibly lead to the conclusion that a causal connection of some kind exists between the chromosomes and the determination of sex; and at first thought they naturally suggest the conclusion that the idiochromosomes and heterotropic chromosomes are actually sex determinants, as was conjectured by McClung in case of the 'accessory' chromosome. Analysis will show, however, that great, if not insuperable, difficulties are encountered by any form of the assumption that these chromosomes are specifically male or female sex determinants. It is more probable, for reasons that will be set forth hereafter, that the difference between eggs and spermatozoa is primarily due to differences of degree or intensity, rather than of kind, in the activity of the chromosome groups in the two sexes; and we may here find a clue to a general theory of sex determination that will accord with the facts observed in hemiptera. A significant fact that bears on this question is that in both types the two sexes differ in respect to the behavior of the idiochromosomes or 'accessory' chromosomes during the synaptic and growth periods, these chromosomes assuming in the male the form of condensed chromosome nucleoli, while in the female they remain, like the other chromosomes, in a diffused condition. This indicates that during these periods these chromosomes play a more active part in the metabolism of the

cell in the female than in the male. The primary factor in the differentiation of the germ cells may, therefore, be a matter of metabolism, perhaps one of growth.

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October 3, 1905.

THE GEOGRAPHICAL DISTRIBUTION OF THE BELL-TOADS.

AT the meeting of the Association of American Geographers in Philadelphia, December 29, 1904, I read a paper on the 'Geographical Distribution of the Discoglossoid Toads in the Light of Ancient Land Connections,'[1] in which I made the following statement:

All indications point towards the country southeast[2] of the Himalayas as the original center of the radiation of the discoglossoid toads, as well as of their near relations the pelodytoid toads. The former are not now found in this region; but that fact weighs but little in view of *Ascaphus* having remained unknown on this continent till 1899, and thus far known only from a single specimen.

This statement assumes almost the character of a prophesy in view of the fact that Dr. G. A. Boulenger, a month later, announced the discovery of a bell-toad (*Bombina*) in the province of Yunnan, near Tong Chuan Fu, at an altitude of about 6,000 feet. This new species, *Bombina maxima* (Boulenger), thus indicates the central form from which both the European and the Korean bell-toads have sprung. Confirmatory of this, it may be mentioned that the new species in most essentials agrees with *Bombina orientalis* and *B. salsa*, the latter being the more southern and, in my opinion, the more primitive of the two European species.

The discovery of this species lends further weight to the theory propounded by me for the migration of this genus[3] in the following terms:

Of the various theories which might be advanced in order to explain this distribution it seems most reasonable at present to select the one which presupposes a comparatively late immigration of this genus from southeastern Asia into Europe after a late Miocene land connection had been established—a theory which would account for the failure of these toads to reach Spain on the one side and Japan on the other.

The supposed original central form in southeastern Asia has now been found, and the theory to a great extent verified almost at the very moment of its publication.

LEONHARD STEJNEGER.
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WASHINGTON, D. C.,
August 31, 1905.

[1] Résumé published in *Amer. Geogr. Soc. Bull.*, XXXVII., February, 1905, pp. 91–93.

[2] In the résumé quoted 'southwest' through a lapsus or misprint.

[3] *L. c.*, p. 93.

HYDRATION CAVES.

THE conclusions set forth in my paper 'On the Origin of the Caves of the Island of Put-in-Bay, Lake Erie,'[1] were based mainly upon observations, made last year, in Perry's Cave. The conditions, however, which exist on the island, led me to believe that the hydration of anhydrite has played an important rôle in the formation of all the caves. At that time I was able to visit three of the four caves open to the public, namely, Perry's, Kindt's and the Crystal Caves. Concerning the other cave, Daussa's, the following statement was, however, made in the paper referred to above: "But inasmuch as this cave is in very close proximity to Perry's Cave, the above explanation, no doubt, also applies to it."

During another visit to the island several weeks ago, Daussa's Cave was visited and it was noted that the fitting of the roof and floor is to be observed fully as well in this cave as in Perry's, leaving, therefore, no doubt whatever as to the origin of the same.

From the general topographic features of the island and the mainland in that vicinity —especially that which is known as Catawba Island—one is led to believe that careful searching should reveal more of these interesting caves, which differ so much in their origin and structure from the ordinary solution cave, that I would suggest they be termed

[1] *American Geologist*, XXXV., 167–171, March, 1905.

hydration caves, because of the fact that, as previously shown, the process of hydration has been such an important factor in their formation.

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A PRELIMINARY NOTE ON CLOVER DISEASES IN TENNESSEE.

FOR a few years past there has been considerable complaint among Tennessee farmers of the failure of the red clover crop. A careful investigation of the question was begun by the botanical department of the Tennessee Experiment Station early in the present season, and a short account of the present stage of these investigations may be of some interest.

While the whole state has been more or less explored with reference to diseases affecting clover, the immediate region about Knoxville has been more carefully studied, and may be assumed as typical of the situation throughout Tennessee, and perhaps adjoining states.

The crop begins to die in the summer following late winter sowing. The trouble has been popularly attributed to some supposed condition of the soil, and so termed 'clover sickness' of the land. It was soon learned, however, that the malady is independent of soil conditions, and there was at the outset a strong presumption in favor of some fungous or bacterial disease. Our later investigations have fully justified this opinion.

Early in the season a few leaves were found to be attacked by the clover rust, *Uromyces trifolii* (Hedw.) Lev. This disease occurs so sparingly that it may be left out of consideration. Careful search frequently reveals the presence of *Pseudopeziza trifolii* (Bernh.) Fuck. While this fungus caused considerable damage in some instances, it may also be left out of account.

A rather destructive disease, apparently caused by *Macrosporium sarcinæforme* Cav.,[1] is very frequent and widely disseminated. It often appears on stray alsike plants (*Trifolium hybridum* L.) associated with the red clover, which is not true of any other parasites discussed in this paper. The *Macrosporium* disease appears capable of destroying the clover plant unassisted by any other parasite, though this statement is based only on inspection in the field.

The most destructive disease thus far found is what appears to be an undescribed species of *Colletotrichum.* In its general appearance this disease very closely simulates the anthracnose of clover (*Stengelbrenner*), described by Mehner[2] and Kirchner[3] and by the latter attributed to the attacks of *Glœosporium caulivorum* n. sp.

The *Colletotrichum* species here referred to causes considerable injury to young clover plants in early summer, where it confines its attacks to the petioles of the leaves. Its greatest damage, however, is done to blooming and fruiting plants, where it attacks the stems most often just below the flower heads, but frequently at other points, causing the sudden blackening and death of a limited region, eventually destroying the entire plant.

A description and characterization of this species will shortly appear, and further experiments now under way will be described in a forthcoming bulletin of the Tennessee Experiment Station.

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A NEW ARMORED DINOSAUR FROM THE UPPER CRETACEOUS OF WYOMING.

THE writer has recently been fortunate in the discovery, near Lander, Wyoming, of the larger part of a skeleton of a remarkable dinosaur, evidently new. The animal is about half the size of *Stegosaurus,* to which it is allied, but is peculiar in having a heavy bony carapace, two inches or more in thickness. This carapace is covered with, and for the most part firmly united to, a mosaic of pentagonal dermal bony plates, much like those of *Glyptodon.* Each plate is about four inches

[1] Cited in Tubeuf and Smith, 'Diseases of Plants,' 1896, p. 517; also Malkoff, *Zeits. f. Pflanzenkr.*, Bd. XII., pp. 283–285.

[2] *Zeits. f. Pflanzenkr.*, Bd. XI., p. 193, 1901.

[3] *Ibid.*, Bd. XII., p. 10.

in diameter, scrobiculate and somewhat elevated in the middle. The whole was evidently covered with a dermal shield, and probably each eminence bore a more or less elongated horny spine. How much of the creature was covered by this heavy shield it is yet impossible to determine; possibly only the pelvic region was so protected, as in *Polacanthus*, since there is also preserved a series of large bony plates or scutes, each of about the size of one's hand, united transversely with each other, and bearing in the middle a prominent longitudinal keel. In addition, numerous flattened bony scutes were preserved, each measuring about three inches in diameter. There are no osseous spines. The bones of the skeleton are solid; the front legs are smaller than the hind ones; the dorsal centra are amphiplatyan, 75 mm. in width by 70 in length, with elevated arches, as in *Stegosaurus* or *Polacanthus*. The head is small, the teeth in size and form resembling those of *Paleoscincus* Leidy. The tibiæ measure 145 mm. in width distally.

The beds in which this interesting specimen was discovered are composed of dark blue shales, from 30 to 75 feet in thickness, immediately overlying and conformable with the Benton Cretaceous. They have been traced continuously for more than forty miles, becoming thinner to the west, where they plainly show littoral and river disturbances. Two continuous lines near the middle, the upper one of white clay, the lower of ferruginous shales, everywhere permit the exact allocation of the fossils. The associated fossils are three or four species of plesiosaurs, one of them clearly belonging in the genus *Polycotylus*, hitherto unknown from above the Niobrara; a large species of a teleosaur crocodile; and a half dozen species of small gastropods and pelecypods, the latter occurring in myriads, in ofttimes massive concretions, about twenty feet above the clay line; plesiosaur bones are sometimes found mingled with shells in the concretions. The invertebrates are of a fresh-water or brackish-water facies.

About thirty feet above these shales there is a layer of sandstone containing rarely a species of *Ostrea;* above which there are about six hundred feet of sandstones and shales containing many characteristic Pierre invertebrates and a varied flora of dicotyledonous leaves. Surmounting the whole are not less than two thousand, and more probably three thousand, feet of light-colored Pierre shales. Fox Hills deposits have not been detected, unless in the massive sandstones immediately below the Laramie deposits.

I believe that the beds containing the vertebrates are of Niobrara age, and they may possibly represent the Belly River. That the dinosaur may prove to be generically identical with *Paleoscincus,* known from the Belly River and Laramie deposits by teeth only, is not impossible. I venture, however, to suggest the name of Hailey shales for the beds containing it, and the name *Stegopelta landerensis* for the dinosaur itself. S. W. Williston.

University of Chicago,
September 28, 1905.

QUOTATIONS.

SHALL THE UNIVERSITY BECOME A BUSINESS CORPORATION?

In the settlement of the larger questions of administration—the choice of president and of professors, the fixing of greater questions of policy—may not some council composed of trustees and faculty jointly share the responsibility to advantage? Whatever may be said in favor of the sound judgment of the well-trained business man, I can not doubt that he would be a wiser councilor for education if he could hear first-hand the views of devoted, intelligent scholars. On the other hand, will not the scholar profit equally by such contact, and is there any surer way to widen his horizon and to give him the experience which ripens judgment than to offer him a share in the responsibility of settling these larger questions, while relieving him at the same time of part of the pressure of the daily routine? In a word, recognition of scholarship in the choice of a president, an adjustment of duties which shall relieve the pressure upon the professor and student, a better contact between the governing body and the teaching body, with a common responsibility in the settle-

ment of the larger questions, seem to me distinct and practical steps in the direction of development which the university administration ought to study.

For one must not forget in considering the administration of a university that there are to every form of administration two sides: the mechanical and the spiritual. The mechanical part of administration is that which provides the machinery necessary to carry out a given enterprise. The other side of administration, the spiritual side, consists in getting out of men the best there is in them. For a set of perfect men any administrative system would suffice. Good administration consists in taking men as they are, with their prejudices, their faults, their virtues, and in getting out of them the highest results of which they are capable.

Now, our attention has been given of late years, in American university life, increasingly to the mechanical side of administration, and the machinery has been made to approximate more and more closely, both in its form and in its choice of executive officers, to the practise of the business corporation. Its very closeness and compactness of organization are in some respects its chief faults. That which is mechanical is always simpler than that which is living. To-day we need, in my judgment, to concern ourselves in the university with the spiritual side of administration.

It has been my purpose rather to state questions than to argue them; not to propose a substitute for our present administration of the university, but rather to point out certain tendencies in it. To inquire whether, if the republic be the ideal system of administration, it is not also a good one for the scholar, and to ask, at least in these days when events move so rapidly, whether the administration of the university as it is now organized tends toward the development of a larger type of professor and a finer order of students; to ask whether we are developing the mechanical side of the administration at the expense of the spiritual side.

For after all, we can never too often remind ourselves that the first purpose of the university is not to further industrial development or to increase the wealth of a state, but that it is the development of the intellectual and spiritual life. This development can take place only in the air of freedom, however evident are the dangers which freedom brings with it. Wealth, power, the niceties of life, may all grow in an atmosphere of limited or of artificial freedom, but only in the air of real freedom can be grown that spirit and that intelligence which shall minister to those things which are spiritual and to those things which are eternal.—President Henry S. Pritchett, of the Massachusetts Institute of Technology, in *The Atlantic Monthly.*

AGRICULTURE IN THE SCHOOLS.

A DISTINCT step in the direction of encouraging the teaching of agriculture in the high school is the movement to recognize that work in the entrance requirements of higher institutions. To a certain extent these higher institutions determine what must be taught in the high schools leading up to them. Heretofore there has been no inducement to schools that were fitting for the colleges and universities to offer such courses, however much they might desire to do so, and no incentive to a student to take agricultural work if it were offered, since it would not entitle him to credit in meeting the entrance requirements.

This matter has been under consideration in several states, for it has been recognized as a bar to progress in introducing agricultural studies. Definite action has now been taken in Missouri. The university in that state practically determines what shall be taught in the high schools, as students are admitted to it on their accredited high school work. Members of the agricultural faculty have been urging that agricultural work in the schools should be given some recognition, and the council of the university has recently decided to allow a credit of one unit on the entrance requirements for a year's work in agriculture in a high school. Boys who are planning to pursue the agricultural course in the university can now take elementary work in the high school without endangering their standing for entrance to the university. It is believed that this recognition will stimulate the

offering of agricultural subjects in the high schools, and that advantage will be taken of this opportunity by a considerable number of pupils. Several of the schools have shown an interest in agricultural work and desired to introduce it, but have been deterred by the necessity of meeting the requirements in the subjects credited.

A somewhat conditional victory in this direction has also been gained in New York state. There the state regents of education determine what subjects are to be credited in the regents' examinations for entrance to colleges or universities in the state, and agriculture has not been included in the list. Naturally no other subjects would be offered at high schools except as electives, and pupils fitting for college would not be likely to take such elective studies with no chance for credit. This has handicapped the college of agriculture at Cornell in its efforts to extend the teaching of nature study and elementary agriculture in the public schools, and that institution has brought its influence to bear upon the regents of education. At a meeting held last winter the regents decided to allow credits in the regular high school courses for nature study and elementary agriculture, provided the courses in these subjects were so prepared as to show educational values comparable with other subjects now recognized. Since this announcement the faculty of the college of agriculture has been at work on the syllabi of courses in the subjects under consideration, with a view to securing their approval by the board of regents. In that case it is expected that several of the high schools will offer elective courses in agriculture, which will enable them the better to prepare students for the higher agricultural work of the college.

It was the contention at the meeting of the Association of American Agricultural Colleges and Experiment Stations at Des Moines last fall, that the public schools should lead up to the agricultural colleges as they now do to colleges of arts and sciences; and President Jesse explained that in Missouri 'we are risking our entire future on the doctrine that the college of agriculture should rest on the public high school, and we are going to make the public high school agricultural so far as it ought to be agricultural.' The recognition of agriculture as a teaching subject and as having an educational value will do much to bring about this desired end. It will bring elementary and advanced work in agriculture closer together, and will articulate the agricultural college and the high school as they have not been before.—*The Experiment Station Record.*

BOTANICAL NOTES.

MORPHOLOGY OF THE EAR OF INDIAN CORN.

MR. E. G. MONTGOMERY, of the University of Nebraska, in a paper soon to be published, offers a new explanation of the morphology of the 'ear' of Indian corn (*Zea mays*). Briefly stated it is that the ear corresponds to the central spike of the tassel. This normally bears from four to eleven rows of paired spikelets. In the staminate inflorescence one of the spikelets in each pair is sessile, and the other stalked, but in their transformation to the pistillate structure the pedicel of the stalked spikelet becomes shortened more and more until it is sessile, thus forming a double row of kernel-producing spikelets, and accounting for the fact that the ear always has an *even* number of rows. Hermaphrodite flowers are common in such transformed spikelets.

A NEW BOTANICAL TEXT-BOOK.

UNDER the name of 'A College Text-book of Botany' Professor Atkinson has brought out (Holt & Co.) an enlargement and considerable improvement of his 'Elementary Botany' (1898). In it the author has attempted to present an outline of the science in a form sufficiently condensed to be readily covered by college students in the time usually allotted to botany in the better class of colleges and universities. The book differs from most of those hitherto prepared in the sequence of topics, beginning with physiology, to which thirteen chapters (135 pages) are assigned. Following this are twenty-four chapters (213 pages) on the morphology of plants. Eight chapters (115 pages) are given to 'Plant Members in Relation to their Environment,' fol-

lowed by twelve chapters (184 pages) on 'Vegetation in Relation to Environment.' Seventy-five pages (9 chapters) are given to the structure and classification of angiosperms. A useful appendix contains suggestions as to the collection of material, the selection of apparatus, reagents, reference books, etc. One has but to note the space given to the subdivisions of the science to realize the change which has taken place in our conception of its scope, and the relative importance of its departments. Roughly speaking, 20 per cent. of the book is given to physiology, 30 per cent. to morphology, 40 per cent. to ecology and but about 10 per cent. to classification. The college student who successfully covers the subject as presented in this book will have a very good introduction to the several departments of the science.

The general decapitalization of generic names when used alone strikes one rather oddly, as when we find spirogyra, vaucheria, uncinula, rhabdonia, riccia, marchantia, etc. Even family names may suffer decapitalization, as 'gramineæ' (p. 658).

KARSTEN AND SCHENCK'S VEGETATIONSBILDER.

QUITE recently several more fascicles of this admirable publication of photographs of vegetation have been received from the publisher, Gustav Fischer, of Jena. As in the earlier fascicles noticed in SCIENCE for April 7, 1905, each of these contains six fine reproductions of photographs accompanied by full explanatory text. Thus fascicle 1, of Series III., contains six photographs by E. Ule of ant nests (Blumengärten) in Brazilian vegetation; fascicle 2, six photographs by Dr. E. A. Bessey, of vegetation in Russian Turkestan (1, moving sand dunes on the Amu Daria River; 2, sand dunes held by Calligonum, Salsola, and Tamarix; 3, *Tamarix laxa* and *Salsola arbuscula;* 4, *Haloxylon ammodendron* and *Salsola arbuscula;* 5, *Calligonum arborescens;* 6, *Cuscuta engelmanni* on a quince tree). The third fascicle is by Dr. M. Busgen, Dr. H. Jensen and Dr. W. Busse, and includes photographs of vegetation in middle and eastern Java. Of these the most striking are those of the teak and bamboo forests. The low price of these beautiful plates (2.50 Marks per fascicle) should enable every botanist to own a complete set.

FURTHER PLANT CELL STUDIES.

SEVERAL months ago (July 7, 1905) parts I. to IV. of Dr. B. M. Davis's 'Studies on the Plant Cell' were noticed in these columns. Since that notice was written two more parts have appeared (*American Naturalist,* July and August). They are devoted to a discussion of cell activities at critical periods of ontogeny in plants, which are taken up under several heads: (1) Gametogenesis (in which we find the suggestion that 'the most satisfactory theory of the origin of sex in plants regards primitive gametes as weaker or lacking in the potentialities of vegetative growth, and conjugation as a mutually cooperative process resulting in a rejuvenescence of the protoplasm'); (2) fertilization (in which the author suggests a narrower conception of the act, by excluding 'vegetative fertilization'); (3) sporogenesis; (4) reduction of the chromosomes (in which much new matter is here incorporated in a concise statement); (5) apogamy (under which he discusses parthenogenesis); (6) apospory; (7) hybridization (in which we find this significant sentence—"the phenomenon of hybridization is far too complex to be explained in terms of simple ratios, and while some characters may be paired or correlated in proportions that can be expressed by mathematical formulæ, there is little probability that the assemblage of characters which make species can be so definitely grouped as the strongest disciples of Mendel may hope"); (8) xenia ('the immediate or direct effect of pollen on the character of seeds and fruits'). Under the last title it is stated that 'the best understood examples of xenia are found in the hybrids of maize.' The whole discussion in these two parts covers ninety-six pages, and includes a bibliography of 152 titles.

A STUDY OF INSECT GALLS.

DR. M. T. COOK, now of the Agricultural Experiment Station at Santiago de las Vegas, Cuba, has brought together in orderly form what is known as to the Indiana plant galls

produced by insects, and this has been published in the 29th Report of the Department of Geology and Natural Resources of Indiana, and also issued as a seventy-page 'separate.' The plan of this brochure is as follows: (1) a short historical section, (2) biology and classification of gall-insects, (3) morphology of galls, (4) causes inducing gall formation, (5) a systematic account of Indiana galls, (6) bibliography. Illustrations from drawings and photographs serve to make the descriptions easier to follow.

This little booklet should stimulate interest in these curious structures, about which there has been practically nothing written in this country in any systematic or connected way until Dr. Cook took up the matter. He is now at work on a monograph of the insect galls of North America, in which the galls will be classified with reference to the host plants, and the treatment is to be primarily from the standpoint of the plant pathologist. It is to be hoped that botanists and entomologists will help in this undertaking by sending him specimens of all kinds of galls from different localities.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

TECHNICAL EDUCATION IN AUSTRALIA.[1]

THE necessity for providing the means of imparting technical education has been unreservedly acknowledged in each of the states of the Australian Commonwealth, the annual combined expenditure in this direction being over £60,000, exclusive of the cost of land, buildings, etc. In Sydney, after successful experiments in the formation of classes by one of the state subsidized educational institutions, a technical education board was established, which did good work until 1889, when the state government assumed control of the movement, the work of technical education being handed over to the state department of public instruction. The technical college, forming the headquarters of the system, is one of the leading architectural features of Sydney. The fronts of the main structure are ornamented with Romanesque carvings in white stone, showing representative flora and fauna of Australia. The main entrance is formed by a triple arch, with two center columns of polished bluestone or trachyte, flanked by two pilasters of the same material. The main building to which access is thus gained has three floors and a half-basement, and contains 28 rooms, many well lighted, lofty and suitable class-rooms. There is a chemical laboratory, and at the rear of the main structure are electrical engineering, plumbing, sanitary engineering, blacksmiths' shops and well-equipped general engineering shops. In 1903 there were 477 technical classes in operation, of which 243 were held in Sydney and suburbs and 234 in the country districts, while there were in addition 86 classes held in connection with the public schools. The number of individual students under instruction during the year was 13,232, and the average weekly attendance 8,671. In 1896 a technical college was opened at Newcastle, and a new college at Bathurst in June, 1898. In 1902 a technical school was built at Lithgow, and mechanical engineering shops provided at Newcastle. During the year the expenditure by the government on technical education amounted to £26,459, exclusive of expenditure on the technical museum and branches. Fees to the amount of £8,707 were received from the students. In Victoria much has been done in promoting the work of technical education, a patriotic Victorian having assisted the earlier stages of the movement by giving £15,500 towards the establishment of a workingmen's college. In 1903 there were eighteen schools of mines and technical schools receiving aid from the state. The total state expenditure during the year was £16,430, and the fees received from students amounted to £11,741. The average number of students enrolled was 3,173. In addition, classes in manual training and in cookery and domestic economy are held at various centers, the net expenditure on these branches amounting in 1902–3 to £3,437. In South Australia the Adelaide School of Design in 1903 had 577 students. There were also branch schools at Port Adelaide and Gaw-

[1] Communicated to the *Journal of the Society of Arts* by Mr. John Plummer, of Sydney.

ler. The School of Mines and Industries, founded in 1889, received state aid in 1903 to the extent of £3,658, while the receipts from fees and sale of materials to students amounted to £3,691. Queensland is beginning to display increased interest in the movement, a board of technical instruction having been appointed in 1902, holding its first examination at the close of 1903, when 960 students were examined, two thirds obtaining certificates of competency. In the same year there were twenty technical schools distributed through the state, with an enrolment of 2,600 students. The amount of fees, etc., collected was £13,385, and that of the expenditure £14,280, showing the system to be almost self-supporting. In Western Australia a technical school has been opened at Perth, having now an average attendance of 190, the annual expenditure amounting to nearly £6,000. Tasmania has also technical schools in Hobart and Launceston, the average attendance, including that of the two schools of mines, being 540, the annual expenditure being under £3,000.

THE INAUGURATION OF PRESIDENT DRINKER.

IN connection with the celebration of Founder's Day, Lehigh University installed its new president, Mr. Henry Sturgis Drinker, on October 12, in the Packer Memorial Chapel. Mr. Robert H. Sayre, president of the board of trustees, made the installation address, which was followed by a brief response from President Drinker. The greetings of the alumni were tendered in an address by Mr. Frank P. Howe, of the class of '78. Following the installation ceremonies, an oration in memory of Asa Packer, the founder of the university, was delivered by the Hon. Hampton L. Carson, attorney general of Pennsylvania, his subject being 'Practical Ideals.' The service in the chapel was then adjourned to the site selected for the erection of the Drown Memorial Hall, where the sod was turned by Mr. Robert H. Sayre, and addresses in memory of the late President Brown were made by Dr. Charles R. Dudley, chief chemist of the Pennsylvania Railroad and chairman of the general committee on the Drown Memorial Fund, and Dr. Rossiter W. Raymond, Dr. Drown's successor as secretary of the American Institute of Mining Engineers. The almuni, faculty and guests of the university were received by the president and trustees at a luncheon in the gymnasium, where in the evening an alumni dinner was given in honor of President Drinker. Addresses were made by Mr. Harlan Sherman Miner, '88, for the alumni; President Isaac Sharpless, of Haverford College, for the invited guests; Bishop Talbot, of South Bethlehem, for the trustees; Professor Mansfield Merriman, for the faculty, and the president of the senior class for the undergraduates.

THE INSTALLATION OF PRESIDENT JAMES AT THE UNIVERSITY OF ILLINOIS.

THE ceremonies in connection with the installation of Dr. Edmund Janes James as president of the University of Illinois is taking place this week. At the inaugural exercises addresses are expected by:

Hon Charles S. Deneen, Governor of Illinois.

Hon. Samuel A. Bullard, president of the Board of Trustees.

Hon. Andrew S. Draper, former president of the university and commissioner of education, state of New York.

after which President James is to deliver his inaugural address and degrees are to be conferred. Professor T. J. Burrill, professor of botany and vice-president of the university, is announced to welcome delegates who are expected to respond as follows:

President James B. Angell, of the University of Michigan, for the state universities.

President Ira Remsen, of Johns Hopkins University, for eastern universities.

Chancellor Frank Strong, of the University of Kansas, for western universities.

President Edwin B. Craighead, of Tulane University, for southern universities.

Vice-President Harry P. Judson, of the University of Chicago, for the universities and technical schools of the state.

President Charles H. Rammelkamp, of Illinois College, for the colleges of the state.

President John W. Cook, of the Northern Illinois State Normal School, for the normal schools of the state.

Principal Benjamin F. Buck, of the Lake View High School, for high schools of the state.

There are being held during the week a large number of assemblies and conferences, including a conference on 'Religious Education in State Universities and Colleges,' a conference on 'Commercial Education' and 'A National Conference of College and University Trustees.' Among those announced to speak at the latter congress are the Hon. Andrew S. Draper, president Henry S. Pritchett and Professor Charles E. Bessey.

SCIENTIFIC NOTES AND NEWS.

IN memory of Professor DeWitt B. Brace, head of the department of physics of the University of Nebraska, whose death we were compelled to record last week, the new physics building, the construction of which he supervised and into which he was about to move, will be named Brace Hall.

PROFESSOR G. E. HALE, director of the Mt. Wilson Solar Observatory, on September 30, gave a lecture in the Cavendish Laboratory, Cambridge University, on 'The Development of a New Method in Solar Research,' and on October 4 he gave a lecture at a special meeting of the Royal Astronomical Society on the 'Solar Observatory on Mount Wilson, California.'

THE medical profession of Chicago will give a banquet to Dr. Nicholas Senn on Saturday, November 11. The committee of arrangements consists of Drs. William A. Evans, Frank Billings, John B. Murphy, William L. Baum and David J. Doherty.

DR. C. H. GILBERT, who has been working during the summer on the deep-sea fishery collections at Washington, has returned to Stanford University.

MR. J. H. BATTY, who has been collecting mammals, birds and reptiles for the American Museum of Natural History in Mexico for several years past, finished his work in southern Sinaloa in November of last year, going thence overland through Tepic to Jalisco, where he has since been making important collections. Several shipments from Jalisco have already reached the museum, containing hundreds of birds and mammals, besides many reptiles and insects, accessories for groups and a large number of valuable photographs. During the last two or three months he has been exploring the fauna of Mount Colima and the adjacent regions.

DR. H. BECHHOLD has been appointed a member of the Royal Institute for Experimental Pathology at Frankfort.

THE Royal Commission on the Care and Control of the Feeble-Minded, consisting of Mr. W. P. Byrne, C.B., Mr. W. H. Dickinson, Dr. H. B. Donkin, Dr. J. C. Dunlop and Mrs. Pinsent, left Liverpool for the United States on October 2 to study American methods of treating the insane.

PROFESSOR W. E. CASTLE, of Harvard University, will lecture before the New York Association of Biology Teachers, on the evening of October 20, his subject being 'The Experimental Study of Heredity.'

PROFESSOR EDGAR L. HEWETT, of Washington, will lecture on October 30 at the American Museum of Natural History before the American Ethnological Society, on 'The Life and Culture of the Tewa Indians in Pre-Spanish Times.'

PROFESSOR H. MARSHALL WARD, F.R.S., delivered the inaugural address at the opening of the present session of the Southeastern Agricultural College, at Wye, England, taking as his subject 'Botany and Agriculture.'

DR. J. W. LOWBER, F.R.G.S., F.R.A.S., of Austin, Texas, has been elected a member of the Royal Societies Club of London.

SIR WILLIAM WHARTON, F.R.S., hydrographer of the British Navy, died at Cape Town, on September 29, of enteric fever. Sir William Wharton was president of the Section for Geography at the meeting of the British Association in South Africa.

DR. WILHELM JOHANN FRIEDRICH VON BEZOLD, professor of physics and meteorology at the University of Berlin and director of the Prussian Meteorological Bureau, died on September 13, at the age of sixty-eight years.

THE death is announced of Dr. Alexander Hay Japp at the age of sixty-six years. He

was a man of letters who wrote a life of Thoreau, books on Darwin and some works on natural history.

M. Alexis Pache, with three natives, was killed in August, by an avalanche, while making explorations in the Himalayas.

The generosity of a friend of the American Museum of Natural History enables the department of ornithology to plan to assemble a special collection of Birds of Paradise. Many species of this family are now becoming so rare that specimens can be secured only with difficulty. Mr. Chapman, associate curator of ornithology, while attending the fourth International Congress of Ornithologists in London recently, took advantage of the occasion to examine the stocks of London dealers in natural history supplies and was fortunate in procuring some desirable material for use in the proposed group.

Peabody Museum of Yale University has received a large cabinet of shells from the estate of the late O. P. Hubbard.

The International Congress of Radiology, which met recently at Liège, has decided to hold another congress in five years, which was placed under the charge of an international committee.

We learn from the *Bulletin of the American Mathematical Society* that the Academy of Sciences of Berlin held its Leibnitz session on June 29. The Steiner prize was not awarded, but the sum of six thousand Marks was set apart in recognition of the investigations of the late Professor Guido Hauck.

The following resolution was passed by the Congress of Tuberculosis recently held at Paris: "The congress, after hearing the *exposé* of the most recent investigations, declares that it is not only indispensable to avoid contagion from man to man, but also to pursue the prophylaxis of bovine tuberculosis and to continue to take administrative and hygienic measures to avert its possible transmission to our species, and finally that it is desirable to be on our guard against all forms of animal tuberculosis."

Professor W. C. Unwin delivered the inaugural address of the opening session at the City and Guilds Central Technical College, taking as his subject 'The Niagara Power Stations.' Professor W. E. Ayrton, the dean, presided. According to the London *Times* Professor Unwin, in the course of his address, which was freely illustrated by lantern views, pointed out that if the total energy due to the fall from Lake Erie to Lake Ontario could be utilized it would amount to 7,000,000 horsepower. At the fall itself the horsepower of the descending water was about 4,000,000. The first great scheme for utilizing the water power resulted in the formation of the Niagara Falls Power Company, who obtained, in 1886, the right to develop 200,000 horsepower on the American side, and later 250,000 horsepower on the Canadian side. Work on a canal and tunnel for 100,000 horsepower was commenced, and in 1890 Mr. Adams went to London to consult the engineers on that side of the Atlantic. A competition for hydraulic and electric plans was started. A commission with Lord Kelvin as chairman was formed to consider the plans. The competition practically settled the hydraulic arrangements to be adopted, but two or three years of conferences and discussion elapsed before a really practicable scheme of electrical distribution for all purposes was threshed out. Professor Unwin gave a detailed description of the plant of the Niagara Falls Power Company, and referred to the chief points of interest in the undertakings of the Ontario Power Company, the Canadian Power Company, and the Electrical Development Company. Dealing with the question of the destruction of the falls, he stated that in 1885 Mr. Evershed thought he was taking a very safe line in saying that for power purposes no more than 4 per cent. would be required. If 150,000 horsepower were produced the daily demand would be 11,000 cubic feet per second, which was 5 per cent. of the mean flow, or not quite 7 per cent. of the minimum flow. The development of 650,000 horsepower demanded 48,000 cubic feet per second, or 21½ per cent. of the mean flow and 30 per cent.

of the minimum flow. It was obvious that when the whole of the machinery was in working order the appearance of the falls would be startling. Taking into account the water used for the Welland Canal and Chicago drainage and other canals projected the total diversion of water would be at least 41 per cent. of the minimum flow. Nor was the end of projects for the diversion yet in sight, so that there seemed likely to be a fulfillment of Lord Kelvin's prophecy that before long Niagara would be a dry ravine.

UNIVERSITY AND EDUCATIONAL NEWS.

SIR DONALD CURRIE has offered £20,000 to Queen's College, Belfast, on condition that an equal sum is otherwise raised. A large portion of the necessary sum has already been promised.

MR. BASIL MCCREA, of Belfast, has given £6,000 to found a chair of experimental physics in Magee College, Londonderry, and to provide two scholarships in connection therewith, on condition of the subscription of funds for a suitable laboratory within a certain period.

THE trustees of the Carnegie Foundation to provide pensions for college professors will hold their first meeting in New York City on the afternoon of November 15.

THE president of the Louisiana State University announces that as the yellow fever quarantines are still in force, it is deemed best not to open the university until November 1. The session will close on June 27, 1906. Perhaps it would be safe to open at an earlier date, but the university authorities wish to be sure of avoiding all danger, not only of infection in the school, but of detention of students by quarantine. There have been seven sporadic cases of yellow fever in Baton Rouge since September 4, but there has been no yellow fever at the university, and no serious sickness of any kind.

THERE have this year registered at Stanford University 590 new students as compared with 488 last year. They are distributed among the departments as follows:

	1904.	1905.
Greek	4	8
Latin	18	23
German	27	28
Romanic Languages	8	14
English	69	87
Psychology	—	4
Education	5	11
History	27	38
Economics	27	29
Law	52	97
Drawing	3	6
Mathematics	14	14
Physics	3	3
Chemistry	24	31
Botany	3	6
Physiology	17	12
Zoology	12	10
Entomology	1	2
Geology and Mining	53	41
Civil Engineering	49	47
Mechanical Engineering	37	33
Electrical Engineering	35	47

THERE are this year 713 students in the freshman class of Harvard University, as compared with 788 students last year.

An instructorship in the department of physics of the University of Pennsylvania is vacant. Applications may be addressed to Professor Arthur W. Goodspeed.

PROFESSOR NATHANIEL BUTLER has been appointed dean of the College of Education of the University of Chicago to fill the vacancy caused by the resignation of Professor H. E. Locke.

AUSTIN CARY, A.B., has been appointed assistant professor of forestry at Harvard University, and R. T. Fisher, A.B., has been promoted to an assistant professorship in the same subject.

PROFESSOR A. EMCH, of the University of Colorado, has been appointed professor of mathematics at the Cantonal College of Solothurn, Switzerland.

DR. TH. PAUL, director of the scientific department of the Bureau of Health at Berlin, has accepted a call to the professorship of pharmacology and applied chemistry at Munich.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, OCTOBER 27, 1905.

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

DeWITT BRISTOL BRACE.

MARKED ability in devising experiments, in minutely observing phenomena, and in correctly interpreting the same, are of themselves sufficient to make a physicist of note. Add mathematical power and, unless circumstances are untoward, our physicist will come to stand among the very few. Such a one was Professor Brace. Nay, he was even more; for with him circumstances were most untoward. The battle was long and arduous before he could build up his department and make his work tell.

When he came to Nebraska the university was poor indeed, the equipment meager. The period when one man taught all the sciences had barely passed. That hither had come a man who could set up his apparatus and spend precious time in investigation was astounding. No wonder the chancellor, who caused to be torn down the shed that sheltered the apparatus, should have thought he did God service.

With the growth of the university came not a parallel growth of the means to carry on the work. The demands of the classroom grew more rather than less exacting. Nor was any work slighted. Those who have served with him on committees know how high were his ideals, how conscientious his purposes, how sane his judgments. Yet for his investigations he was able here and there to snatch a moment; so that, during term time, he was at least able to determine and plan the lines his work should follow during vacation. Gradually he gathered about himself enthusiastic students whom

he trained up as co-workers. Moreover, these would work with him through the vacations. Thus, all last summer, frequently till late at night, one could find, in the old basement laboratory, professors and students immersed in work.

More than once he had attractive calls to the east. Yet, because he felt that on going elsewhere he would have to begin all over again with great loss of time, these calls were refused. Had he known how long he would have to wait for the promised new laboratory; had he known that he was never to work in it: even then, I believe he would have stood by the work he had entered upon here.

In spite of all difficulties he was turning out several papers yearly. This summer he was just able to finish and send to *The Philosophical Magazine* a paper on 'Fizeau's Method in Ether Drift.' This will probably rank with a former paper 'On the Resolution of Light into Circular Components in the Faraday Effect.' In the November number of *The Physical Review* he will have a paper 'On Anomalous Dispersion and Achromatic Systems of Various Types.'

Thus did he work to the very end, 'without haste, yet without rest.' Need it surprise us then that those with him caught his inspiration and that the publications of the department, mostly prepared during vacations, should number some forty or more papers?

When can we Americans learn that 'in universities truly worthy of the name,' place should be made for investigation throughout the year; that those fitted for investigation should be untrammeled, perhaps even encouraged to engage therein. Might it not be better to reserve for vacations solely the command 'thou shalt not investigate'?

But it is something that the laboratory he has done so much to create may be named in his honor; and it is more that the band of devoted workers he had gathered about him will therein have the opportunity, as they have the absorbing purpose, to carry to complete and perfect fruition his pregnant ideas.

Cut short in the beginning of his triumphs he will, nevertheless, be ranked among our physicists along with Gibbs and Rowland.

Ellery W. Davis.
The University of Nebraska.

EDUCATIONAL PROBLEMS AT YALE UNIVERSITY.[1]

The recent history of our large universities shows the growing importance of providing land for museums and bureaus of research.

A university has to deal with two classes of problems—those which arise out of its relations to its students, and those which arise out of its relations to the general public. Most discussions of university work concern themselves chiefly with the relations of the institution to the student body. We try to arrange a course which shall meet the needs of the students; we organize the work of the professors with the same end in view. Three quarters of the time of the corporation and more than nine tenths of the time of the faculties is occupied with the consideration of problems involving the welfare of the students primarily or exclusively.

But this is not the whole work of a university. It must care for its students in this way; but it must do something far more than this. Its relations to the general public are, I believe, quite as important as its relations to its students. It is something more than a large school or group of schools. Its professors can be occupied with something better than the discussion of student discipline. The noble definition

[1] From the annual report of President Hadley.

of President Wilson, that a university is a place where many are trained to the love of science and letters and a few to their successful pursuit, may, I think, be given a broader application than its author had in mind. A university should be a place which promotes the love of science and letters and the understanding of the liberal arts not only among the few thousands who may happen to be its pupils, but among the many thousands with whom it comes less closely in contact. The work of a university is to maintain standards. It can hardly succeed in that work if it confines its inspiration to the relatively small number who have had the good fortune to live within its walls. It must appeal at once to its smaller constituency within its walls and to its much larger possible constituency without them.

Yale men have always recognized this responsibility and have done a great deal of work for the community. But Yale has taken less credit and less advantage from this than it might wisely have done. The relations of this public work to the university have been unnoticed. Its status here was so far undefined that it has been taken out of our hands the moment it has achieved public recognition. I suppose that Yale University may fairly claim to be a starting point of modern scientific agriculture. Certainly the development of agricultural experiment stations, which have proved so important in revolutionizing the practise of our farmers, and have done so much to increase the productivity of our soil, started from Sheffield Scientific School. This movement has extended all over the world. Its cardinal importance in theory and in practise is everywhere recognized. But nobody gives the credit to Yale. We hear of what Wisconsin does for agriculture; we hear of what half a dozen other universities do. Of Yale, we hear chiefly of what she has failed to do. Why? Simply because this whole important movement was in its initial stages carried on so quietly that its importance never properly impressed itself upon our graduates or upon the public; and those universities reaped the benefit which, seeing the real importance of the work Yale was doing, gave it the recognition which we had withheld.

We are in danger of repeating the same kind of error to-day. We are in danger of ignoring the existence and usefulness of some of the things among us which are most important for our public influence. Whenever a reception is held in the galleries of the Yale Art School many men speak with wonder of the fact that they have neglected for years a means of enjoyment and culture which stood ready to their hand. Scarcely one in ten among the Yale students or graduates knows the extraordinary value and interest of our art collections. If our own students do not realize seriously what we have in the way of art treasures and what we might do with them for our own culture, we can hardly expect the outside public to realize it more fully. Our various scientific collections are somewhat better known than our art collections, both to the students and to the public; but even these fall far short of having the usefulness which they might well attain in stimulating scientific interest among the students and throughout the city.

The means which we can use to bring our work more fully into contact with the public may be grouped under five heads:

1. The natural history collections in the Peabody Museum. Of these the most widely known are the fossil vertebrates originally collected by Professor Marsh. Going out as he did at the time when the fossil beds of the Rocky Mountain region were first opened, Professor Marsh had exceptional opportunities for obtaining

material, and in his own particular line of discovery our museum has ranked as the first in the world. Since Mr. Marsh's death his work has been ably carried on, first by Professor Beecher and now by Professor Schuchert. Both of these gentlemen have done a great deal in making the collections accessible to the public; and they would have done a great deal more had they not been handicapped by lack of funds. For the Peabody Museum has practically no endowment for its support, and is dependent upon the small sums which the university can furnish out of its current income. Of scarcely less attraction to the casual visitor are the mineral collections, under the charge of Professor Dana; while we have important material for study both in zoology and in anthropology. It is exceedingly desirable that these different collections should be better known to the citizens of New Haven and their children. A most important connection between university work and public-school work can be made on this line, which would help to give us our proper place in the educational system of the city. The little which has already been done in bringing high school pupils into the museum is proving valuable, both to the children and to us. It is, I hope, only a beginning; an indication of the possibilities which we have before us when we are ready for more organized cooperation with the schools.

2. In the art school we have two unique collections; the Jarves collection of Italian paintings in the north gallery, and the Trumbull collection of early American paintings in the south gallery. The Jarves collection, apart from its value to the student of art history, has a number of pictures of the very first rank, and has been supplemented by others which Mrs. Derby has placed in our charge—so that we can now show excellent specimens of Botticelli, Correggio and other Italian artists of scarcely inferior prominence. Of even more interest to the general public is our collection of modern pictures, of which the Trumbull collection formed the nucleus. Viewed simply from the standpoint of the student of history, the battle pictures by Colonel Trumbull and the contemporary portraits of Washington, Hamilton and other leaders of the American Revolution, are exactly what a university needs to create the right kind of atmosphere within and the right kind of influence outside. No other American university owns art collections approximating ours in value, if we would but avail ourselves of the advantage which they give us. The failure to do this is not the fault of the art school. This school is doing active work in regular classes and evening classes, public lectures and loan exhibitions. It renders us more public service than we appreciate; and it only needs proper recognition in order to make that service many times greater than it is at present.

3. The public work of our music school is somewhat better known. Indeed, this department of the university may serve as an example of what can be done in the way of public service with somewhat small materials, provided men like Professor Parker and Professor Sanford are in charge. With relatively small means at command this school has developed a symphony orchestra which serves at once as a laboratory for the students of music and a means of enjoyment and education to the public. It has repeatedly brought audiences of three thousand people to Woolsey Hall to hear music of the very highest class. Besides these concerts of our own, we have the benefit of visits by great artists from outside; and, what is perhaps still more remarkable, all this part of our university activity has been placed on a self-supporting basis. It has at the same time stimulated an increased interest in the study of

oratorios and choruses among the people of New Haven, under the leadership of various members of our musical faculty. Nor should we fail to mention the importance of the collections given by Mr. Steinert, now housed in the upper floor of Memorial Hall, whose historic importance is parallel to those in our art galleries and museums.

4. Still another development of outside activity is seen in our public lecture courses. These are by no means a new thing. Almost from its very beginning the Sheffield Scientific School has arranged year by year a course of public lectures on scientific subjects under the title 'Lectures to Mechanics.' A few years ago some of the people in New Haven, of their own initiative, organized a 'New Haven University Extension Center,' and arranged for somewhat similar courses of lectures, covering the fields of literature and art as well as science. The advantage of cooperation between the university and the citizens of New Haven was so obvious that we are now working together instead of separately, and by this combination we can keep the grade of the lectures high and at the same time reach a wider range of hearers than would be otherwise possible.

5. The most recent development of our public activity has been connected with the appointment of Dr. Sneath as professor of the theory and practise of education. Professor Sneath's work consists of three distinct parts. He gives regular instruction in his subject; he takes charge of the newly organized summer school; and he arranges means for closer communication and interchange of ideas between Yale and the teachers in various parts of the country. Of the value of his work as an instructor, both to graduate students and to teachers, it is unnecessary to speak. Of his work in organizing the summer school it will be more appropriate to speak in next year's report, when we have a season behind us, than to attempt to prophesy in advance. It will be sufficient for the moment to say that the prospectus of this summer school, issued as a bulletin of Yale University in February, 1905, is a document which every Yale man may read with satisfaction. But, useful as such a summer school may prove, I regard Professor Sneath's work in communicating with the teachers as having even greater importance. At much sacrifice of time and labor, he has made journeys through different parts of the country, especially in the south; and he has at every stage of his journeyings helped us to bring the effect of our Yale life and Yale standards home to those who can not come to Yale as well as to those who can. He has shown the school men of the country what we are trying to do in such a way as to help us to work together instead of separately.

I have purposely confined attention in this summary to the public activities which we already are in position to exercise, without mentioning those which are merely projected. A word should, however, be said of the plan for a forest museum which is in the mind of Mr. Gifford Pinchot. The Yale Forest School was organized just at a time when the American public was beginning to see the importance of the subject. We have had the good fortune to take the lead in this line of education, so that students come to us from every quarter of the world. Mr. Pinchot feels that it would be possible, by the establishment of a museum in connection with this school, to take the same position before the public as a whole that our courses of instruction have given us in the minds of students and specialists, and to make Yale the center to which the whole world will turn for its record of progress in forestry in the past and its suggestions of possible lines of progress for the future. Mr. Pinchot has already realized so many of his ideals that

we may look forward with confidence to his success in whatever he undertakes. I mention it at this moment as indicating the kind of public work which makes the modern university something more than a mere group of schools and elevates it to its highest possible rank—that of a public servant.

Besides its function in maintaining these public collections and lectures, a university should also be governed by a sense of public obligation in arranging its courses of study.

I have in a previous report spoken of this public duty as affecting the freedom of a university in determining the requirements for admission to its professional schools. However convenient it might be to insist on the possession of a bachelor's degree by all pupils in the schools of law and medicine, I feel that it would be a violation of our duty to these professions to hedge ourselves about by any such artificial limitations. We should make the standard of admission to our law and medical schools higher than it is at present; but we should base it upon qualifications for professional study which we could test by an examination, rather than upon previous residence at an institution entitled to give a bachelor's degree. If a man is really fit to study law or medicine we should encourage him to study law or medicine with us, without making arbitrary restrictions.

Considerations of public duty have an important bearing in determining what we shall require for entrance to our undergraduate courses also.

The whole question of entrance requirements is often discussed as though these were things which the college had a right to fix for itself. This is an error. There is a great difference in this matter between the position of a public institution, such as we think Yale to be, and a purely private one. If a man keeps a private school he can make any rules which he pleases regarding the admission of his pupils. If we think these rules are arbitrary or whimsical we may question their wisdom, but we can never for a moment question his right to make them. The case is different with a public institution. If a place like Yale, honored by the presence of the highest officers of the commonwealth in its corporation, and exempt by law from many of the taxes which are paid by others, should choose to make its rules arbitrary, the public would have a grievance. It would say, and say justly, that Yale had exceeded its rights.

Yale is charged with the public duty of educating a large number of boys who, having reached the age of seventeen or eighteen years, and having acquired the freedom which naturally goes with that age, desire to spend time in the acquisition of general culture and broad points of view before narrowing themselves down to the work of the office or the shop. She will err if she makes her requirements so lax as to encourage the coming of idlers, who will waste their own time and interfere with the seriousness of purpose of their fellows. But she will also err in the opposite direction if for her own convenience she makes those requirements so narrow that hard-working boys in the high schools and academies of different parts of the country can not get the teaching which is needed in order to enable them to enter Yale.

It is wrong to say that whatever Yale requires the schools will furnish. Some schools doubtless will; others will not. If the Yale requirements should get so far out of the line of work furnished by the better kind of high schools in the country that we could not expect to get boys from those schools, we should soon become a local institution. Yale would be a school for boys of one kind of antecedents, instead of for boys of all kinds of antecedents; and as soon as it became a school for boys of one kind of antecedents only, it would lose its

value as a broadening influence to its students and as a factor in the life of the whole nation.

Our policy with regard to entrance requirements is thus governed by two separate considerations: our duty to ourselves of not admitting boys except those who are able to do the kind of work which will be required of them; and our duty to the public of admitting all kinds of boys who can do this, on as equal terms as possible. Our student body must be at once hard working and national.

In order to make ourselves national we admit boys to our undergraduate courses by examination only and not by certificate. We believe that the examination method is fairer to boys who come from distant places. The certificate system is the natural one for a state university, which draws its pupils chiefly from the schools of one locality and can inspect and examine those schools; but if a national university tries to apply this system it gives either an unfair preference to the boys from schools near at hand, or an inadequate test to the boys from remote ones. We believe also that the examination system brings us the kind of boys who can take the best advantage of the opportunities we offer. By refusing to admit on certificate we lose some good boys who are afraid of an examination; but as a rule, the boy who is afraid to stand an examination on a subject where he has been well taught is better fitted for the protection of a small college than the liberty of a large one.

The subjects of our examination must be such as to prove whether the student can or can not pursue our courses to advantage. We must have enough mathematics to test the power of precise thought and enough language to test the power of precise expression. We can not allow other subjects to be substituted for these merely because we believe that it is a good thing to have these other subjects taught in the schools. In this respect our policy has differed radically from that of Harvard. When the question has come up of introducing music or wood-working among the entrance requirements, the question with Harvard has been mainly, How far does the college desire to encourage the teaching of music and of wood-working in our high schools? The question with Yale, on the other hand, has been, Can a student who is deficient in grammar be properly admitted to the college because he knows music? Can a student who is deficient in certain parts of his algebra properly be admitted to the scientific school because he understands wood-working? Every new subject introduced as an alternative to the entrance requirements means not simply that we are ready to cooperate with the schools in teaching that subject, but that we value it sufficiently to be content to get on with less than we formerly required of the things which were once considered essential.

On account of this difference in view Harvard has gone rapidly in the introduction of alternative entrance requirements, while we have gone slowly. Our scientific school has not found that the submission of notebooks and experiments, or the examination which could be given in various forms of descriptive science, could well be made a substitute for mathematical theory. It has indeed encouraged pupils from schools where there were good laboratories to pass a supplementary examination on laboratory practise and has admitted them to advanced sections; but it has insisted that these examinations should be regarded as supplementary to the regular requirements instead of excusing the student therefrom. Our academic department has introduced modern languages as substitutes for ancient languages only when they could be made real substitutes. We accept French instead of Greek only when it is a

real equivalent to Greek. Whatever language a boy presents, we insist that his knowledge of it should be precise. We do not let general information take the place of a knowledge of grammar.

It has been charged by critics of the old system of classical study that Greek has been a college fetich. This certainly has not been the view at Yale. We required Greek in the past not because we worshipped Greek, but because in times past the Greek teachers in the schools were the ones who were best able to insist on certain kinds of training which we thought our students needed. Some schools now have French teachers who can give this same kind of training in French. We are ready to accept the boys from those schools with French instead of Greek. To do this is not a departure from our old principles, but a continuation of it. The majority of French teachers are as yet unable to meet our requirements regarding French. Hence the majority of pupils who try to substitute French for Greek fail. Professor Wright's report shows that it is considered fully as hard to enter Yale without Greek as with it. This proves that the widening of the requirements has not been accompanied by a lowering of the standards.

It is probable that as more teachers of modern languages become acquainted with the requirements of the Yale examination we shall get a larger number of freshmen who prepare in modern languages instead of Greek. But this will not prove that we have changed our standard. It will prove that the schools have changed theirs. By adapting our choice of subjects to the needs of the schools we can make the schools adapt their method of teaching to our needs.

In order to do this we shall probably continue to hold separate examinations instead of joining with other colleges. We recognize the high degree of skill with which the Harvard examinations have been conducted. We recognize also the value of that cooperation between schools and colleges which is exemplified in the management of the Middle States' Examination Board. Under proper restrictions, we can accept some of the results of these examinations in determining the fitness of the pupil to enter Yale. But there is enough difference of purpose between us and Harvard to make a strong argument for those who wish our separate examinations continued —and the demand for their continuance, by the way, comes even more strongly from the schools than it does from the members of our own faculty. The Harvard paper seeks to test knowledge; the Yale paper seeks to test accuracy. The Harvard examination tries to find how well a boy has done his work in school; the Yale examination tries to find how well the boy is going to be able to do his work in college. The Middle States' system is intermediate between the Harvard and the Yale systems in these respects, and it is possible that in the near future we may all come together on this median line. We shall certainly do it whenever the great majority of the secondary school teachers demand it. But the results of the correspondence in the report of the Dean of Yale College indicate that the demand for separate papers is stronger than the demand for one consolidated paper. There is a large number of school teachers who find the accuracy incident to the Yale method of examination a great help in resisting certain evils which the widening of school courses during late years has brought with it.

SCIENTIFIC BOOKS.

Outlines of Industrial Chemistry, A Textbook for Students. By Frank Hall Thorp, Ph.D., Assistant Professor of Industrial Chemistry in the Massachusetts Institute of Technology. Second edition. New York, The Macmillan Co. Price $3.50.

This is a revised and enlarged edition of the work first published by Professor Thorp in 1898. While the earlier edition noted the most important inorganic and organic industries, the subject of metallurgy was entirely passed by because, as the author stated, instruction in it is generally given independently of that relating to technical chemistry. In this newer edition, however, he has thought it best to include an outline of elementary metallurgy and this, therefore, covers 54 pages and constitutes Part III. of the book.

Thorp's 'Chemistry' is too well known to need an introduction to teachers of chemistry, and its well-merited success has brought about a revision that can not but help to make it more generally acceptable for purposes of instruction. While it is obviously impossible for any one man to write with the authority of personal acquaintance with the dozens of distinct industries and hundreds of special manufacturing methods now in active use in this country and abroad, Professor Thorp has made diligent use of the literature, references to which are found at the end of each section, and he has, in his capacity as a teacher, made numerous visits with his classes to industrial plants and witnessed the actual working of many chemical processes. Indeed, the evidence of this is found so unmistakably in his frequent use of workmen's factory terms, given in quotation marks, that it has the effect, not always to be desired, of localizing the particular process described.

In general, the accounts of the individual chemical industries are clearly given, accurate and brought up to date. We note in this connection the account of the sulphuric acid manufacture, in which both the older chamber method and the newer contact processes are very satisfactorily explained and illustrated. The chlorine industry also is very fully treated, although some of the methods described will probably only have an historical interest before many years with the rapid development of the electrolytic methods for chlorine and caustic soda, in which the chlorine is the product for which sufficient utilization has to be sought. These electrolytic processes, by the way, are also very well presented and described.

The account of the manufacture of nitric acid is equally good, embodying as it does recent improvements like Guttmann's and Hart's and the experimental work at Niagara Falls on the production of nitrogen oxides from the action of high-tension electricity on the atmosphere.

We note similarly satisfactory sections on the fertilizer manufacture, and mineral colors or pigments, which latter is quite full and is supplemented by a list of well-selected references.

With these many points of excellence it may be allowed to note one or two cases in which the presentation of the subject is not quite up to the general standard. The statement on page 41 that 'the price of the foreign sulphur brought into this country is too low to allow profitable working of the deposits in this country' was true a few years back, but in 1904 the Union Sulphur Co. of Louisiana produced 200,000 tons of a native sulphur of exceptional purity and began the invasion of the European markets. To prevent the serious crippling of the Sicilian sulphur industry, the Anglo-Sicilian Sulphur Co. has just made a compact with the American Company, by which they give the latter the undisturbed field of the United States and a part of Europe in return for the maintenance of prices. Similarly the statement of the American bromine production methods on page 227 is hardly an adequate picture of the industry which within the last two or three years has had a great development in Michigan, in consequence of the use of electrolytic methods for liberating chlorine.

Part II., devoted to the 'Organic Industries,' covers exactly the same number of pages in the treatment as the Inorganic portion, and is also in the main very satisfactorily dealt with. This is especially true of the section on 'Explosives and on Textile Industries.' The same is true of other sections, although in the account of petroleum we do not find much mention of the radical differences in composition, and consequent differences in practical value, in the American petroleums, such as Pennsyl-

vania, Ohio, California and Texas crudes, that we might expect. In the section on 'Fermentation' also we find no mention of Buchner's great discovery of zymase in the expressed liquid from comminuted yeast-cells, which is now considered as the greatest advance in our knowledge of the action of the yeast plant since the time of Pasteur.

Part III., written for this edition by Charles D. Demond, S.B., in the space of 54 pages, gives a very excellent survey of metallurgical methods, covering all the technically important methods.

The book is undoubtedly the best book of its kind in the English language, covering in one volume of moderate size an outline of the manufacturing methods of technical chemistry. SAMUEL P. SADTLER.

Inorganic Chemistry, with the Elements of Physical and Theoretical Chemistry. By J. I. D. HINDS, PH.D. Second Edition. New York, John Wiley & Sons. 1905. Large 8vo. Pp. viii + 651.

This work, on its first appearance, was carefully reviewed in this journal; it seems necessary, now, only to show in what respects the present edition differs from the former.

The plan of the book remains essentially the same, but there has been an increase of eighty-five pages, and the text has been revised. Several chapters have been enlarged or rewritten, and new chapters have been added. These changes affect mainly 'Theoretical and Physical Chemistry.' The treatment of these subjects is much better and fuller than in the earlier edition, but unnecessary *rules* and questionable statements may still be noticed. Is it well that a student should write structural formulas of acids by the following rule: 'Connect each hydrogen atom by an oxygen atom to the negative, then connect the remaining oxygen atoms, which are saturating, to the negative by both points'? Is it correct to say that 'the reaction of a salt is neutral'?

Although blemishes like the above are still too numerous, they are noticeably less than they were in the first edition. The excellence of the descriptive portion of the text is unquestioned, and the work in its present form should win new friends. L. B. HALL.

HAVERFORD COLLEGE.

Cements, Limes and Plasters, their materials, manufacture and properties. By EDWIN C. ECKEL, C.E., Associate, American Society of Civil Engineers, etc.; Assistant Geologist, U. S. Geological Survey. New York, John Wiley & Sons. 1905.

This is an exceedingly valuable and well-nigh exhaustive work. It is by far the most valuable work on the several subjects that it treats that we have met, and in our judgment may be rightly considered a masterpiece of compilation. In the orderly and systematic arrangement of sub-subjects in the several parts and chapters the author's mastery of his general subject is exhibited not only to his own credit, but to the great pleasure and profit of his readers; for next to the enlightening information conveyed by an author comes the proper unfolding of a subject through systematic arrangement.

It is, however, as an engineer, of broad attainments outside the field of engineering, that Mr. Eckel addresses engineers. He does not profess to be a chemist, the chemistry of cements, limes and plasters is not mentioned in his title, therefore he may be pardoned if in the small space he devotes to the chemistry of these substances he follows the well worn path made by Mr. S. B. Newberry and Mr. Clifford Richardson's committee, which for some reason not clear to the general reader leads direct to the manufacturers of cement, leaving the interests of the *users* of cement completely uncared for. Nothing else could be expected, as Mr. Richardson's committee has the floor, and that committee recommends a method of chemical analysis that is ultimate and that, so far as chemical analysis is concerned, destroys the differences that exist in very unlike cements. A cement that contained five per cent. of uncombined silica and fifteen per cent. of combined silica would show twenty per cent. of silica on analysis by the method recommended by Mr. Richardson's committee, while a cement containing twenty per cent. of combined silica would on ultimate

analysis appear to be no better than the one first mentioned.

While in our judgment Mr. Richardson's committee is all wrong, and will ultimately be admitted to be so, it is hardly to be expected that Mr. Eckel would do otherwise than he has; nevertheless the book, addressed as it is mainly to those who *use* cements, limes and plasters, while well-nigh complete in other respects, is deficient in respect to furnishing a method of chemical analysis that will give results that enable one to distinguish good cements from bad cements.

We congratulate those seeking information upon this interesting subject that Mr. Eckel has given them such a comprehensive and valuable work.

A Treatise on Concrete, plain and reinforced; materials, construction and design of concrete and reinforced concrete. With chapters by R. Feret, William B. Fuller, Spencer B. Newberry. By Frederick W. Taylor, M.E., and Sanford E. Thompson, S.B., Assoc. M. Am. Soc. C. E. New York, John Wiley & Sons. 1905.

The preface of this work states: "This treatise is designed for practising engineers and contractors, and also for a text and reference book on concrete for engineering students."

As hydraulic cement is the basis of all concrete structures, this announcement exhibits the book as designed to inform and instruct those who *use* cement. While many of the technical and engineering problems involved in the use of cement in mortar and concrete are of interest to us, we naturally turned to those portions of the book devoted to the chemistry of cements and cement mortars. A careful examination of the book reveals an exceedingly interesting chapter by Mr. Spencer B. Newberry (a very successful manufacturer of Portland cement), on the 'Chemistry of Hydraulic Cements.' We found nothing in this chapter especially designed to instruct the *users* of cement. We looked in vain through the body of the work for anything concerning the analytical examination of cements, cement mortars and concretes. In an appendix we found the 'method suggested for the analysis of limestones, raw mixtures and Portland cements, by the committee on uniformity in technical analysis of the American Chemical Society, with the advice of W. F. Hillebrand.' As a method of ultimate analysis of the substances named the method proposed is well-nigh perfect; but for any purpose associated with the technical composition of cements, cement mortars and concretes, it has no value whatever.

The authors of this book are not chemists, hence they may be excused for any defects in the book involving a purely chemical problem; nevertheless, with all the good qualities the book possesses it is a defect that the book does not contain a scheme of chemical analysis by means of which good cements can be distinguished from bad cements and also by means of which the analyses of cements and cement mortars and concretes may be correlated with one another and with the physical tests of the cements used. We believe the time is not far distant when those who *use* cement will be brought to realize the supreme importance of such a method.

S. F. Peckham.

Technique de psychologie expérimentale (Examen des sujets). In Toulouse's 'Bibliothèque internationale de psychologie expérimentale.' Toulouse, Vaschide et Piéron. Paris, O. Doin. 1904. Pp. 335.

The scope of this work is much more limited than the first title would indicate; the subtitle indicates more exactly the ground covered; yet the scope is still narrower than this at first suggests. The book does not, of course, attempt to condense into one small volume the whole subject of experimental technique in psychology; it limits itself definitely to the technique of 'tests,' by which the mental traits of individuals are measured. But, further, the book makes no attempt to cover the already rather extensive literature of mental tests; it scarcely refers at all to other authors. Its sole and consistent purpose—a purpose which has guided the authors in several years of experimentation, of which this book presents the outcome—is to formulate a system of mental tests which shall take

rank as the standard tests, and so introduce order into the existing confusion, and make the future results of different workers in this field comparable with one another. The principal difficulty to which the authors address themselves is the selection of materials and conditions which can be described with such scientific precision as to be reproducible from the mere description by any other worker. For example, in a specially difficult test to standardize, that for sensitiveness to faint colors, the authors use aqueous solutions of analin dyes; light passes through the solutions, under definite conditions, to the subject's eye, and his sensitiveness is measured by the strength of the weakest solution in which he detects the color. This seems, on the whole, the most ingenious of the authors' innovations, of which there are many. In addition to determinations of the least noticeable sensations and differences in sensation, the authors suggest a system of tests on memory, association, imagination, judgment, reasoning, attention, etc. They frankly point out the gaps in their system, which they are as yet unable to fill satisfactorily. A chapter is devoted to the general technique of experimentation, the necessity of noting the condition of the subject, and of excluding certain subjects as unsuited to psychological tests, the proper attitude toward working hypotheses and toward the literature of a question, the necessity, in addition to quantitative tests, of less rigorous observation, which should, however, be brought up as nearly as possible to the exact standard of experimentation. An appendix of sixty pages is devoted to the reprinting of tests which can be fully presented in alphabetical or musical notation.

In view of the slack attention to standard conditions that characterizes much work in psychology, this book should do considerable good. As the most serious attempt to present a standard series of tests, it is worthy of attention and a large measure of acceptance. It can not hope, of course, to be definitive, and, indeed, the authors repudiate any such claim. More is to be gained, perhaps, by insistence on the general principle of standard and exactly reproducible conditions, than by the conformity of all workers in the field to any one set of tests.

R. S. Woodworth.

Columbia University.

SCIENTIFIC JOURNALS AND ARTICLES.

The first number of *Economic Geology*, a semi-quarterly journal devoted to geology as applied to mining and allied industries has been issued under the editorship of John Duer Irving, of Lehigh University. The associate editors are: Waldemar Lindgren, Washington, D. C.; James Furman Kemp, Columbia University; Frederick Leslie Ransome, Washington, D. C.; Heinrich Ries, Cornell University; Marius R. Campbell, Washington, D. C., and Charles Kenneth Leith, University of Wisconsin. The contents of the first number are: 'The Present Standing of Applied Geology,' Frederick Leslie Ransome; 'Secondary Enrichment in Ore-Deposits of Copper,' James Furman Kemp; 'Hypothesis to Account for the Transformation of Vegetable Matter into the Different Varieties of Coal,' Marius R. Campbell; 'Ore-Deposition and Deep Mining,' Waldemar Lindgren; 'Genesis of the Lake Superior Iron Ores,' Charles Kenneth Leith; 'The Chemistry of Ore-Deposition—Precipitation of Copper by Natural Silicates,' Eugene C. Sullivan; Editorial; Discussion; Reviews; Recent Literature on Economic Geology; Scientific Notes and News.

The American Museum Journal for October is termed the Batrachian Number, its major portion being devoted to an illustrated synopsis of the salamanders, toads and frogs that have been found within a radius of fifty miles of New York City. The text is by R. L. Ditmars, illustrations from photographs by Herbert Lang, mainly of animals living in the New York Zoological Park. W. M. Wheeler tells 'How the Queens of the Parasitic and Slave-making Ants establish their Colonies,' and announcements are made of three courses of lectures, for members, pupils and teachers, in October–December. There are, besides, many notes concerning additions to the collections and other features of interest at the museum. The figures of the batrachians are

excellent, the nearly life-size picture of a bullfrog that forms the frontispiece being particularly fine.

The special feature of the *Zoological Society Bulletin* for October is the announcement of the reception at the park of a young African elephant of the small-eared species, from West Africa known as *Elephas cyclotis*. Few realize that specimens of the African elephant are far more uncommon in this country than mastodons and it is quite probable that this specimen is the first of the species seen in the United States. Other interesting animals on exhibition are the great anteater, echidna, crested screamers and ruffs.

The Museum News (Brooklyn) for October has for its longest article an account of the rearrangement of the insect room at the Children's Museum, to better adapt it to the needs of teachers and children. The collections comprise a very considerable number of the local insects, examples of the largest and smallest insects in various orders, and instances of striking differences between the males and females. These are supplemented by small groups showing life histories, interesting habits, protective coloration and mimicry. There is an extended series of lectures at the Children's Museum for pupils. Various changes are noted at the Central Museum, in the main already announced in Science. An interesting addition to the collection illustrating variation is a group of eleven ruffs, *Pavoncella pugnax*, in full breeding plumage, showing the striking differences found among these birds.

SOCIETIES AND ACADEMIES.

THE AMERICAN CHEMICAL SOCIETY. NEW YORK SECTION.

The first regular meeting of the season was held at the Chemists' Club, Friday evening, October 6, 1905. The program of the evening was as follows:

R. H. Williams and H. C. Sherman: *The Detection, Determination and Rate of Disappearance of Formaldehyde in Milk.*

Using a method which permits approximate estimation of any amount of formaldehyde greater than 1:160,000, it was found that even aqueous solutions of formaldehyde of 1:10,000 to 1:40,000 lose strength steadily on standing at room temperature, the loss being due to an actual destruction, and not merely to polymerization, of the formaldehyde; while when added to milk in the same proportion formaldehyde disappears ten to twenty times as rapidly as from water.

The hydrochloric acid and ferric chloride test is capable of showing 1 part of formaldehyde in 250,000 parts of milk. Sourness of the milk does not in itself diminish the delicacy of the reaction, but when milk is preserved by means of formaldehyde the latter will have largely disappeared before the milk becomes sour. Considerable data regarding the time required for the disappearance of the reaction is given.

The gallic acid test, applied to the distillate obtained from the milk after acidulation with sulphuric acid, is much more delicate than the hydrochloric acid and ferric chloride test, and gives more conclusive results with samples which have stood until the formaldehyde has largely disappeared.

J. B. Whitney and S. A. Tucker: *Observations on the Preparation of Metallic Calcium by Electrolysis.*

The method used was that of J. H. Goodwin, and the attempt was made to improve the yield of the metal. The electrolyte was molten calcium chloride. The apparatus used at first was similar to Goodwin's and the results obtained agreed satisfactorily with his. It was found that the proper temperature limits were so difficult to maintain that a new form of kathode was devised, in which the temperature of the iron rod was kept down by water cooling. With this improvement the yield of calcium was increased to sixty per cent.

A modification of the kathode was tried in which the iron kathode was inclosed by an insulated graphite bell, the object being to prevent the oxidation and chlorination of the calcium as formed, but it was not found to work well in operation.

F. H. Pough,
Secretary.

SAN FRANCISCO SECTION OF THE AMERICAN MATHEMATICAL SOCIETY.

The eighth regular meeting of the San Francisco Section of the American Mathematical Society was held at the University of California on September 30, 1905. During the morning session the following officers were elected for the ensuing year:

Chairman—R. E. Allardice.
Secretary—G. A. Miller.
Program Committee—E. J. Wilczynski, D. N. Lehmer and G. A. Miller.

Seventeen members of the society were in attendance; in addition to these there were present a number of high school teachers of mathematics who are not members of the society. The following papers were read and discussed during the two sessions of the section.

Professor C. A. Noble: 'Note on Loxodromes.'

Dr. W. A. Manning: 'Groups in which a large number of operators may correspond to their inverses.'

Professor M. W. Haskell: 'A new canonical form of the binary sextic.'

Professor A. O. Leuschner: 'On a new method of determining orbits.'

Professor Arthur Ranum: 'The representation of linear fractional congruence groups with a composite modulus as permutation groups.'

Professor E. J. Wilczynski: 'On a system of partial differential equations in involution.'

Professor G. A. Miller: 'The groups which contain only three operators which are squares.'

Professor R. E. Moritz: 'On logarithmic involution, the commutative arithmetic process of the third order.'

Professor L. E. Dickson: 'The abstract group simply isomorphic with the general linear group in an arbitrary field.'

Professor L. E. Dickson: 'The abstract group simply isomorphic with the symmetric group.'

Professor M. W. Haskell: 'On a class of covariants which give rise to birational transformations.'

The next meeting of the section will be held at Stanford University on February 24, 1906.

G. A. Miller,
Secretary of the Section.

DISCUSSION AND CORRESPONDENCE.

STEGOMYIA AND YELLOW FEVER—A CONTRAST.

The magnificent work done in New Orleans this summer and autumn in fighting the yellow fever outbreak on the sole basis of the transfer of the disease by *Stegomyia fasciata*, and which has resulted in the practical extirpation of the epidemic long before the first frost, has convinced the most stubborn among the citizens of New Orleans and many other cities and towns throughout the south of the fact that only in this way can an epidemic successfully be handled. The acceptance of what has been termed 'the mosquito theory' is now almost universal, and this brings us to the contrast.

In the *New Orleans States* of May 2, 1902, appeared an article with the following scare headlines: 'Taxpayers to Protest Against Passage of Anti-mosquito Ordinance. Has been Resurrected. A Meeting To-night. Property Holder Discusses Taxation without Benefit.'

In the body of the article the following statements are made:

An effort will be made to resurrect the anti-mosquito ordinance at the next meeting of the committee on police and public buildings to which are entrusted for consideration all questions pertaining to public health. The measure was introduced last November by Mr. Cucullu at the request of Dr. Q. Kohnke, president of the city board of health. The measure was not popular, as the taxpayers contended that its enactment was but another form of enforced taxation. * * * Because of its evident unpopularity, the promoters of the ordinance requested that it be not pressed, and for that reason it has remained untouched before the committee ever since.

In the meantime the endorsement of medical men and organizations has been sought with more or less success, so that now Dr. Kohnke feels that the chances are more favorable to call the measure up. * * *

But there are many taxpayers who are determined to resist the passage of the ordinance, and should it be defended by the committee on police and public buildings at its meeting next Monday evening * * * there will be taxpayers present who will strive to prove to Dr. Kohnke that the arguments in favor of this new venture are not so strong and convincing as he believes.

A special meeting of this taxpayers' protective association has been called to be held this evening at 7:30 o'clock. * * *

'The passage of the proposed ordinance,' said a prominent taxpayer this forenoon, 'would be nothing short of an outrage.'

I wonder what this 'prominent taxpayer' thinks about the ordinance now. It is a sad thing to suggest, but possibly he himself or some member of his family has died as a result of the senseless opposition, in which he took part, to a reasonable and public-spirited health measure.

In an evening paper of March 28, 1902, there appeared a note to the effect that a correspondent of the Associated Press had a talk with the State Health Officer of Texas, regarding the mosquito theory. He was reported as of the opinion that 'The theory won't hold water,' and stated that he would not accept it. He stated that he had been familiar with yellow fever from childhood and 'knew enough to keep rigid quarantine and disinfecting rules in effect.' A little more than a year later, however, he had a new lesson in the Texas outbreak of yellow fever in the late summer and autumn of 1903, and he too changed his mind in regard to mosquitoes.

L. O. HOWARD.

THE POSSIBILITY OF ABSORPTION BY HUMAN BEINGS OF NITROGEN FROM THE ATMOSPHERE.

ANY one reading this article would conclude that it has been proved that plants can absorb free nitrogen from the atmosphere without the aid of bacteria, and that Dr. Wohltmann is a believer in this. The quotation which the writer gives does not bear out this interpretation of Dr. Wohltmann's work:

The association of the plant with the bacteria is not a necessity but an expedient, and whenever there is a rich supply of nitrogenous elements in the soil, they (the plants) dispense with the bacteria and *with the free nitrogen*, which the latter make available, by directly secreting it from the chemical combination of soil or air in which it is held suspended.

The italics are mine, but the translation is by Mr. Gibson. Dr. Wohltmann is far from saying that plants absorb free nitrogen in the absence of bacteria; but distinctly says, in the above quotation, that in the absence of the bacteria they dispense with the free nitrogen and take the nitrogen necessary for their growth in combination from the soil.

This is no new discovery, for Hellriegel, in 1886 and later, showed by decisive experiments that when the bacteria are absent, Leguminosæ, like other plants, can only take their nitrogen in compounds, and their growth, within limits, is a function of the combined nitrogen presented. In the presence of bacteria Leguminosæ can utilize the free nitrogen of the air, and build it up into organic compounds.

Before speculating on the possibility of the absorption of free nitrogen by human beings, it is well to remember that there is no evidence that higher plants can assimilate nitrogen of the air without aid of bacteria.

G. S. FRAPS.

A TREE'S LIMB WITHOUT BARK.

TO THE EDITOR OF SCIENCE: In the summer of 1902 a large ash tree, some two feet in diameter, on the university campus was struck by lightning. The current, after knocking off a few branches, passed down on both sides of the main trunk leaving here merely two small furrows in the bark. From one limb, some six inches in diameter and perhaps ten feet from the ground, the bark all around was completely stripped for a distance of about five feet. To the surprise of some of us the leaves on this branch did not wither, nor fall to the ground till the leaves of the rest of the tree fell in the autumn. The next spring the leaves put out on this branch as on the rest of the tree; so again in 1904 and again the present year. In other words, the vegetation of this branch, wholly girdled for a space of several feet, differs from that of the rest of the tree only in being slightly less vigorous. The wood of the girdled portion looks much like a seasoned log of ash wood. The tree itself is rather less vigorous than the neighboring ashes, and will probably survive but a few years longer. Is it common for a limb,

stripped of its bark, to thus survive for three seasons? JAS. LEWIS HOWE.

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SPECIAL ARTICLES.

PHYSICAL CHARACTERS AND HISTORY OF SOME NEW YORK FORMATIONS.[1]

WE are accustomed to define historical geology as the history of the earth and its inhabitants, and this definition no doubt fully covers the subject. But it may be questioned if, in the ordinary treatment of the subject, such as it receives in our current text-books and lecture halls, we do it justice to the full extent suggested by our definition. Is it not too often merely the history of the inhabitants of the earth that we are treating, giving the history of the earth itself, *i. e.*, its physical development, only scant recognition? I believe I am not going too far when I say that we give proportionately too much attention to the biologic or paleontologic side, and too little to the physical or stratigraphic. I do not wish to be understood to say that paleontology receives too much attention in our institutions of learning. Far from it. Paleontology is not receiving a fraction of the attention it requires, and which it will receive in the future when our curricula are more normally balanced. But paleontology is not the whole of historical geology. Stratigraphy, or the physical characters and physical history of the rocks of the earth's crust—paleophysiography (if I may use a pet term, in spite of objections raised against it)—is fully one half of historical geology.

It is true, of course, that historical geology reposes on a foundation of paleontology—the divisions of the earth's history are based on the progress of life, and not, as has been too often assumed, on breaks in the sedimentary series, extensive and important as these may be. The standard of comparison must be a series of sediments which contain a continuous record of development, and since it is only in marine sediments that we get a continuous series, only marine formations, and such as do not represent merely local conditions, must be selected as our standard of reference.

Much as we prize, and justly prize, the classical standard of our North American Paleozoic series—the incomparable column furnished by the strata of the state of New York—and loath as we may be to attack any part of it, yet we must confess that it is not a perfect column throughout, and that the imperfection which it embodies can not be overlooked. Indeed, the sworn guardians of this monument have themselves recognized that it is an incomplete structure, and have introduced such foreign elements as the Cincinnatian group and the Richmond formation, besides accepting emendations proposed by others, such as Acadian and Georgian. They have, however, sought consolation for this forced recognition of the imperfections of the New York series, by proposing that the world at large accept the broader terms of the New York classification—Taconic, Champlainic, Ontaric—in place of the better known, though not always prior, terms Cambric, Ordovicic and Siluric.

But it is one thing to recognize the absence of an element in the standard series and to fill the gap by a foreign representative, and another to regard an old and well-known formational unit as imperfect, and as inexpressive of the time element which it represents, and to acquiesce in its replacement by another. Yet I believe this is what we shall come to in the case of such old standards as the Medina sandstone and the Salina group, not to speak of the Oneida conglomerate, formations which are still tolerated in the standard scale of North American Paleozoic formations, but which in a very imperfect manner represent the chronologic epochs for which they are commonly used. This is due to the fact that they were not deposited in the open sea, but rather under peculiar conditions, *i. e.*, estuarine, if not continental, in the case of the Oneida and Medina, and salt sea, if not desert, conditions in the Salina. Moreover, it is now pretty well ascertained that the typical Oneida

[1] An address delivered before Section E, American Association for the Advancement of Science, Syracuse meeting, July 21, 1905.

conglomerate of Oneida County is the time equivalent of the Upper Medina of the Niagara section, and that both probably should be united to the Clinton, while the lower 1,100 feet of the Medina of western New York may possibly represent the continental or estuarine phase of deposits, representing elsewhere the later Richmond period.

A satisfactory standard for the Lower Siluric is found in the island of Anticosti; and although this belongs to another geographic province of the Siluric seas, it represents far more completely the progress of biologic development than do the lower beds of the New York Siluric or, for that matter, any other Siluric beds deposited in the Siluric Mediterranean; unless the Mayville beds of Wisconsin should prove to represent the lowest Siluric.

To go, for a moment, outside of New York state, the same argument applies to the sediments of the mid-Carbonics, or Pennsylvanian, of eastern United States. Though now taken as a standard for comparison, to which all other Carbonic formations of North America are referred, they are manifestly unfit for this important position, not only because they represent continental conditions, and do not furnish us with a standard of marine sedimentation, but because it is obviously impossible to determine, at least with our present means, how complete the series is. There may be, and probably are, vast breaks in this series of non-marine sediments, breaks which may or may not be revealed in the floral succession. A far more satisfactory standard, and one more nearly comparable with the European standard, is that furnished by the mid-Carbonic sediments of Arkansas, Missouri and Kansas, or by those of Texas. When these sediments and their marine faunas have been fully studied we shall have a mid-Carbonic standard worthy of the name; and when that is accomplished—as we have good hopes that it will be before long, judging from the results already achieved by the labors of the earnest workers in those fields—then let us hope that the inappropriate term Pennsylvanian will be replaced by one more expressive of the marine sedimentation of that age.

But I am not here to speak of the imperfection of the geologic record, an imperfection which I think is more apparent than real, nor of the imperfection of our classification, which is more real than apparent. What I have said, however, will serve to define my position with reference to the importance of paleontology to the geologist. Let me return, then, to the consideration of the importance of the physical characters of our formation. I believe that the general neglect which this phase of the subject has suffered is in part due to the clumsy and unrefined nomenclature which we have inherited from the fathers of our science, and which, with the tacit, if not expressed, understanding that what was good enough for them is good enough for us, we have retained to the present time. So long as we express in our nomenclature that all stones composed of lime are limestones, and nothing more, so long, I believe, progress in the study of physical stratigraphy will be hampered. So long as we are content to use indiscriminately the structural terms slate and shale for rocks which have no other claim to these names than that clay generally enters into their composition—if that may be considered a claim—so long progress in this direction will be retarded. Naumann and Hauy long ago proposed textural terms for the three great types of clastic rocks, but these have been mostly overlooked by modern writers except the Germans, who are far ahead of us in the study of physical stratigraphy. It is true the terms of Naumann and Hauy, derived from the Greek, are not very euphoneous, nor do they lend themselves readily to composition, yet they are much better than indefinite descriptive phrases. Calcopsephyte and calcopsammyte do not fall pleasantly on the ear, yet they are far better than the indefinite terms, brecciated limestone—which might mean limestone brecciated by subsequent causes—or granular limestones—which might mean a number of different things. Certainly calcopelite is far better than the vague and roundabout phrase: 'compact, fine-grained limestone with conchoidal fracture,' which leaves you still in doubt whether the rock in question is a clastic, composed of lime flour, or a massive

organic rock in which all organic structure has been obliterated. Personally, I prefer terms derived from the Latin as being more adaptable in composition in this instance than the Greek terms of Naumann and Hauy; but whether we say calcopsephyte, calcopsammyte and calcopelyte or calcirudyte, calcarenyte and calcilutyte, is of minor significance, so long as we employ a term which will express exactly the physical characters of the rock. If the name at the same time expresses, in part, the history of the rock, by indicating it to be a clastic and not an organic rock, this can only be regarded as a further advantage. Certainly, if you understood that a lutyte was a clastic rock composed of fine rock flour, you would, I think, be in favor of describing many of the beds of the Manlius and water-lime of this region as argillaceous calcilutytes or pure calcilutytes, as the case may be, rather than to speak of them as: 'compact, finely-bedded argillaceous limestones with conchoidal fracture and of an impalpable grain.' I should, at any rate; for, if nothing more than brevity is gained, the short term is a distinct advantage.

But the application of a more precise nomenclature to the clastic rocks is only a first step in the right direction. The lithic character of the rocks must be studied with reference to their origin, *i. e.*, the lithogenesis of the formations must be considered, and the bearing which this has on the distribution of land and sea in past geologic epochs. The careful study of local sections, the measurements of thicknesses and the determination of the distribution of fossils, are of course, an important preliminary. But while this is done, a careful diagnosis of the lithic character of the rock and a determination of its source should be made, and special care should be given a precise description of its relationship to adjacent formations. The latter feature is too often neglected, when it is of the greatest importance, as an example will show. Most of the descriptions of the Chattanooga black shale which I have been able to find speak of it as a black bituminous shale, with some few additional remarks on its petrographic character. They mention the fossils which are found in it and refer the formation to the Devonic, with sometimes a more precise reference to the Marcellus or the Genesee of New York. But its relation to the succeeding formation is almost never discussed. Here and there in the literature we find a hint, and only a hint, that it grades up into the overlying rock. Rarely is there a more precise description of this gradation, like William's description of its relation to the overlying Grainger shale. And yet this is of very great importance, for if the Chattanooga shale of eastern Tennessee is Devonic, then there is not only a pronounced hiatus at its base, but another at its top, for the immediately overlying Fort Payne beds represent in some localities the St. Louis, in other the Keokuk. In still other localities we find beds of Chester age following immediately upon the black shale, which often is only a few feet thick, while in other localities again these black shales are succeeded by beds of Burlington or Kinderhook age. If, as I strongly suspect, and as seems to be occasionally hinted at in the literature, there is no hiatus at the top of the black shale, but a transition to the overlying formation, then the black shale surely represents the basal formation formed by a sea transgressing southward and eastward over a peneplained land surface, and its age varies in different localities. At the type locality, Chattanooga, Tennessee, the age of the black shale is in that case Burlington or perhaps early Koekuk, while at others its age is St. Louis, or even later. Only in the northern region, where it is succeeded by Kinderhook beds, as at New Albany, Indiana, and at Big Stone Gap, Virginia, is the black shale of Devonic age.

And this brings me to the consideration of another factor which is all too often overlooked in stratigraphic work. This is the phenomenon of progressive overlap, and the complementary one, which, for lack of a better term, we may call regressive overlap. We all agree that in normal sedimentation coarse clastic rocks are formed near shore, finer farther out and the finest impalpable flour is only deposited at a great distance from the normal shore, while clastic limestone may be

formed anywhere under favorable conditions. But we do not generally apply this principle in the elucidation of our rock sections. When, for example, a prolonged subsidence of the land occurs, resulting in the overflow of the land by the sea, the waves of the advancing sea will work over the residual soil of the land which it overflows and will spread a basal layer of conglomerate or sand or, in rare cases, of mud over the old land thus submerged, the nature of the basal bed depending on the character of the rock débris which covered the old land, the slope of this old land and the consequent depth of the encroaching sea, and the rapidity of the submergence. This latter may be so great that areas of land are suddenly submerged, while the shore is transferred far up on to the old land, so that offshore deposits, like organic limestones, may form directly on the old land surface.

The basal layer thus formed will not be of the same age throughout, but will rise in the scale with the advance of the sea. Seaward, finer deposits will be laid down upon the basal formations, these finer deposits corresponding in age to the basal sandstone at that time forming near the shore. To illustrate: the basal sands of the Cambric Ocean were spread by an advancing sea over the crystalline rock floor. East of Lake Champlain this basal sandstone belongs to the Lower Cambric, but westward it rises in the scale until at the foot of the Adirondacks it is the Potsdam sandstone of Upper Cambric age, while the corresponding deposits further east are clay and lime-rocks. Again, while on the east of the Adirondacks, at the point of present outcrops, the basal sandstone is Potsdam, followed by calciferous sand-rock and by purer calcarenytes of Beekmantown age, the outcrop on the west of the Adirondacks shows similar basal quartz sandstones, followed by calciferous sand-rock and later by pure calcilutytes, but all, from the base up, of Lowville or Upper Chazy age. The Beekmantown and Potsdam are here overlapped by the later deposits, which, however, repeat the lithic sequence seen in the section of earlier age on the east of the Adirondacks. Wells sunk in the neighborhood of Syracuse to the crystalline rock, find a quartz sandrock (silicarenyte) resting immediately on the crystalline, followed by a calciferous sand rock (calcareous silicarenyte), which grades up into siliceous calcarenyte, and finally into pure calcarenytes or clastic limestones. Lithically considered, this section might be regarded as representing the whole series from Potsdam up, whereas in reality the basal bed is Beekmantown, if not Upper Chazy.

Regressive movements of the sea, by which large tracts of previously submerged land become exposed, also leave a record in the sedimentary series which, by careful consideration, can be detected. Thus a comparison of sections shows that we have in the Mohawk Valley some three or four hundred feet of Beekmantown, which in places, as at Little Falls, rests directly upon the gneiss with a basal rudyte. These Beekmantown beds probably represent the lower, though probably not the lowest, members of that formation, judging from the presence of *Opheleta complanata*. Not more than a hundred and fifty miles south, in central Pennsylvania, the Beekmantown is represented by over two thousand feet of similar strata, followed by some two to three thousand feet of the Stone's River group, which in the Mohawk is represented by less than a hundred feet of its upper portion, and there known as Lowville. Similarly, in the upper Mississippi region the Lower Magnesian limestones, which indicate a continuous deposition from the Upper Cambric, are less than three hundred feet in thickness and represent the lowest Beekmantown. The Stone's River, or Chazy, is represented by less than a hundred feet of strata, which grade upward into the Black River, as do the corresponding strata—Lowville—in the Mohawk and Black River Valleys. These Stone's River beds of Minnesota, from their relation to the overlying beds, and from their fossils, are seen to be the uppermost portion of that series. Between the lowest Beekmantown and the highest Chazy (or Stone's River) lie about 200 feet of pure quartz sandstone—a typical silicarenyte—known as the St. Peter sandstone. This sandstone has been traced very widely over the Mississippi Valley region; but as

we follow it southward the thickness of Beekmantown below and Chazy above increases more or less regularly, until in Indian Territory, where the St. Peter thins away, we have nearly two thousand feet of the Beekmantown and more than that of the Chazy or Stone's River. These facts point to a very remarkable episode in North American Ordovicic history, namely, the slow retreat of the sea from the upper Mississippi Valley, which as it retreated gradually washed the sands of the northern shore seaward, spreading them over the previously deposited offshore beds. As the sea retreated, deposition came, of course, to an end. Thus when the retreat had reached southern Minnesota, only the lower 250 feet of Beekmantown had been deposited, and there deposition stopped. When the retreating seashore had reached central United States, only the lower thousand feet of Beekmantown had been deposited, and only in southern United States, which was not laid bare, was there a complete deposition of the calcarenytes and organic limestones of the Beekmantown. The area uncovered—the whole of central United States—was spread over by the sand left by the retreating sea, and this was no doubt blown about by the wind, the grains rounded and the remarkable structure and purity of the St. Peter—probably the best example of an ancient desert rock extant—was thus produced. When the sea again advanced over this desert area, the upper portion of these sands was worked over and became true water-laid deposits, and at the same time graded up into the overlying calcareous beds. By the time the sea had advanced half way to the old northern shore, a thousand feet, more or less, of the lower Chazy had been deposited in the southern states. At the point then reached Chazy deposition began with the middle members of the formation. By the time the sea had reached its northern shore, from which it originally retreated, and which was somewhere north of Lake Superior—the whole of the Chazy—nearly 2,000 feet had been deposited in the southern states, the upper thousand in the central states, but only the uppermost 50 or 75 feet in southern Minnesota. The St. Peter, thus representing a retreatal sandstone, worked over by the winds, also represents a basal bed of an advancing sea; and while the last remnants of it in southern United States mark practically no break in the sedimentary series, this same rock in southern Minnesota occupies the interval between all but the lowest Beekmantown and all but the highest Chazy.[2]

Now, in New York state we have no St. Peter, but we have the other conditions precisely like those of the upper Mississippi Valley. The lowest Beekmantown is followed by the highest Chazy, the interval unrepresented between the two being marked in central Pennsylvania by over 4,000 feet of sediment. This break, or stratigraphic unconformity, long suspected, has recently been actually located in the Mohawk Valley by Professor Cushing. It should be remarked that during all the time that central and western New York was dry land, *i. e.*, during the time occupied by the formation of 4,000 feet of limestone strata elsewhere, continuous or nearly continuous deposition went on in what is now the Champlain Valley.

We must now consider a somewhat more complicated series. In western New York the Lorraine beds—considered the highest of the Ordovicic—are followed by red lutytes and arenytes (mud-rocks and sand-rocks), over a thousand feet thick, and unfossiliferous. At the base is a quartz sandstone, about 75 feet thick, and over it are about a hundred feet of quartz sandstones, mostly red, and some shales which contain marine fossils closely allying them to the overlying Clinton. I speak, of course, of the Medina formation. A little south of Utica, the Lorraine shales, represented only by their lower hundred feet, are succeeded by the Oneida conglomerate, a pure quartz-pebble conglomerate with well-rounded pebbles. This conglomerate, less than 50 feet thick, is followed by the shales, sand, mud and lime rocks of the Clinton. The base of the conglomerate is fossiliferous, the fossil—*Arthophycus harlani*—being the same which is restricted to the top beds of the Medina in western New York. In the cement region of

[2] Dr. C. P. Berkey will shortly publish a detailed discussion of the St. Peter problem.

Ulster County a similar white quartz-pebble conglomerate, the Schawangunk grit, lies unconformably upon the upturned and eroded Hudson River beds, and is followed by less than a hundred feet of red lutytes and arenytes, and then by the cement beds, which, by their enclosed fossiliferous bands, prove their identity with similar beds overlying the Salina in western New York. Close inspection of the series shows continuity of deposition, which proves the age of the red beds and the Schawangunk conglomerate to correspond to that of the New York Salina. Still further east, in Rensselaer County, a similar conglomerate, the Rensselaer grit, rests unconformably on Cambric and Hudson beds. How shall we interpret these sections? At the end of Ordovicic time the folding of the Ordovicic strata of eastern United States took place—what is familiarly known as the Green Mountain revolution. So far no strata later in age than Lorraine have been found in these folded beds; hence it is safe to assume that strata of Richmond age were never deposited in eastern United States; in other words, that the folding began at the end of Lorraine time. This folding was, no doubt, accompanied by an elevation of the land, and a westward retreat of the interior sea. Elevation of an old land is commonly followed by vigorous stream activities, which results in erosion. In the present case the products of this erosion were spread by the streams over the land exposed by the retreating sea. This is the ultimate mode of origin of the conglomerates in question and of the red sandstones. The red colors of the sands and muds indicate that they are the product of the subaerial decay of rocks; and the only rocks at all competent to furnish the material of these strata are the crystallines of the Appalachian old land, as long ago pointed out by Davis and others. That the conglomerates and their representative in western New York, the basal sandstone of the Medina, are, in part at least, river deposits, later on worked over by the sea, seems unquestionable, for though the retreating sea would wash out seawards the materials of the shore, such thick masses of pebbles can hardly be carried so far from their source without the aid of rivers. A comparison of the Siluric sections of the Appalachians suggests that the conglomerates and sandstones are part of a huge subaerial fan, whose apex was in southeastern Pennsylvania, and which thinned away radially in all directions. That a part of this fan was formed during Richmond time seems probable, and is further indicated by the occurrence of marine Ordovicic fossils in what was probably the margin of the fan in Virginia. However, a great deal of careful comparative study is needed to unravel the complete history of these deposits.[8]

In central United States the Richmond is succeeded by marine deposits commonly correlated with the Clinton of New York. Though land conditions, accompanied by erosion, are indicated in many localities, in some cases the lowest Siluric sediments seem to rest directly upon the highest Ordovicic. It is impossible to determine from the literature whether in any of these cases continuous deposition occurred or not. Further field examinations will have to settle that. Marine conditions came into existence again in western New York in Upper Medina time, and gradually transgressed eastward. The Siluric sea reached as far as Utica in Upper Medina time, but did not reach Ulster County until the conditions of the deposition of the Salina beds were instituted in central and western New York—if at that time marine conditions existed at all in New York. The continued red sedimentation, which is so pronounced throughout the Salina sediments and which appears to indicate a continuous supply of highly oxidized material from the old land on the east, and, further, the presence of true Salina strata only along the inner margin of the Appalachians, their great thickness in the east and their thinning away to the west, all suggest that land conditions, rather than marine, existed in this period. That marine deposits were forming in some region is indicated by such sections as that near Cumber-

[8] Investigations of this problem are now in progress under the auspices of the New York State Geological Survey.

land, Maryland, but the typical salt and gypsum-bearing Salina beds, such as furnish the salt of Syracuse, have characters which seem explicable only on the supposition that all this region was a desert country, with much evaporation and comparatively little rainfall, and that the basins in which salt accumulated were shallow pools, rarely, if ever, flooded by the sea, the salt being bleached out of the surrounding marine sediments by the occasional rains and left by the evaporation of the water. But here, as in the case of the Medina, much detailed study of the lithic character of the formation is necessary before we can do more than make provisional hypotheses. We know, however, that marine conditions were reestablished over all New York towards the end of Siluric time. As Hartnagel and Schuchert have shown, the sea invaded eastern north America by a transgression of the Atlantic waters. At the same time a trangression from the southwest appears to have occurred, which brought with it a different type of fauna, the two together constituting the Cobleskill. The Manlius limestones represent typical marine conditions; but you will have noticed that many of the lime mud-beds or calcilutytes show mud cracks, which indicate water so shallow that occasional emergence was possible. The Manlius beds grade upwards into the fossiliferous calcarenytes, which, as the Colymans limestones, form the basal Devonic beds of the New York section. This and the higher beds of the Helderbergian series are now no longer found, except as remnants, in this region, erosion having removed most of them. You will bear in mind that this erosion was a pre-Onondaga erosion, for the Onondaga rests everywhere in this region upon the eroded surfaces of the Colymans or the Manlius. This erosion belongs to Oriskany time, for continuous deposition into the Lower Oriskany is shown by the section at Becraft Mountain. What the amount of erosion was and what the length of time during which it was accomplished, we have at present no means of judging. There is every reason to believe that the highest Helderberg strata extended at least as far as Syracuse, and there is reason to suppose that they extended farther and overlapped the lower ones. But the Oriskany erosion has removed all this. The hiatus, though pronounced, is scarcely noted by the casual observer, because the formations are perfectly conformable, so far as position of strata is concerned. We need a term to express the relation where two formations thus conform in their bedding but comprise between them a time break of greater or less magnitude. To speak of such strata as unconformable, without qualifying the term, is misleading, since it suggests that the older strata have suffered folding and erosion before the deposition of the later. Until a better term is proposed, we might speak of such formations as *dis*conformable, leaving the term unconformable for cases in which discordant relationship of bedding occurs.

The disconformable relation of the Onondaga upon the Manlius or Colymans is sometimes qualified by the occurrence of lenses of Oriskany between them. The relationship of the Oriskany and other overlying formations is best brought out by the consideration of a few sections. In the Hudson Valley the lowest Oriskany—that of Becraft Mountain—is a direct successor, without break of deposition, of the uppermost Helderbergian, the Port Ewen. It is succeeded by about three hundred feet of dark argillaceous silicilutytes, the lower part of which are the Esopus and the upper the Schoharie. Above this come the Onondaga limestones, the transition being a complete, though rather rapid, one. In the Schoharie Valley later Oriskany rests on eroded Helderbergs, and is followed by about 100 feet of the dark lutytes, mostly of Esopus or Caudagalli age. West of this region the Oriskany occurs at irregular intervals, while the Esopus has thinned away. Finally, at Cayuga Ontario, half-way between Buffalo and Detroit, the uppermost Oriskany alone occurs, resting on eroded lower Manlius and intimately related with the overlying Onondaga. Here, then, is no room for Esopus or Schoharie, for Onondaga is the direct and immediate successor of latest Oriskany. This indicates a westward transgression of Oriskany sediments. the later beds overlapping

the earlier ones. The dark mud rocks, therefore, are the shore equivalents in the east of the highest Oriskany limestones of the west, and not an independent unit in the time scale.[4]

But I must not carry my discussions further, since my time, unfortunately, is limited. I hope you agree with me—those of you, I mean, who are not stratigraphers, for stratigraphers require no conversion at my hands—that the study of the physical characters of the strata, even of the thickness of sections, gives, when rightly attacked, a view of the history of the earth, full of dramatic intensity, and that only by a careful study of such physical characters can we arrive at a true interpretation of the history of the earth.

A. W. Grabau.

Columbia University.

EXTIRPATION AND REPLANTATION OF THE THYROID GLAND WITH REVERSAL OF THE CIRCULATION.

We have successfully removed and then replanted a thyroid gland with reversal of the circulation on a dog.

A transplantation of the thyroid with anastomosis of its vessels to a suitable artery and vein was previously made in 1902,[1] but no permanent successful result was obtained, owing to the obliteration of the vessels by clots and the subsequent development of gangrene. A careful investigation of the literature has revealed no other mention of similar experiments having been performed hitherto. The present observation is also the first successful replantation of a gland with reversal of the circulation.

Summary of the Technique and of the Observation on the Results of the Operation.—The right thyroid gland of about a 20 K. dog having been dissected, all its vessels were ligated, except the superior thyroid artery and vein, which were cut near the carotid artery and the internal jugular vein. The gland was then extirpated and put in a glass of isotonic sodium chloride solution.

After a few minutes, the thyroid gland was placed in the wound in the neck, and the peripheral end of the thyroid artery was united to the central end of the thyroid vein, and the peripheral end of the thyroid vein to the central end of the thyroid artery.

The circulation was reestablished about half an hour after the extirpation. The circulation through the gland was in a direction reverse to the normal. The red blood entered through the thyroid vein, and the dark blood flowed from the gland to the jugular vein through the thyroid artery. The hue of the gland was normal, and the circulation very active.

Eleven days after the operation the wound was opened and the anterior portion of the gland directly observed. The gland was somewhat enlarged, but its hue and consistency were normal.

Twenty-five days after the operation it was again directly observed. It still appeared enlarged, and in hue and consistency the same as before.

Thirty-two days after the operation, the wound being almost closed, it was not possible to examine the gland directly. But by pressing it between the fingers through the skin, its systolic expansion was easily detected.

At the present time forty seven days after the operation the animal is alive and in good condition. The replanted gland appears to be practically normal, being only slightly enlarged.

Alexis Carrell,
C. C. Guthrie.

The Hull Physiological Laboratory,
University of Chicago.

[4] A more detailed discussion of this problem appears in my forthcoming bulletin on the Schoharie Valley (Bull. N. Y. State Museum).

[1] A. Carrel, 'La Technique operatoire des anastomoses vasculaires et la transplantation des visceres,' *Lyon Medical*, 1902. 'Les anastomoses vasculaires, leur technique operatoire et leurs indications,' 2e Congrés des Médecins de langue francaise de l'Amérique du Nord, Montreal, 1904.

EXHIBITION OF EARLY WORKS ON NATURAL HISTORY.

Few people are aware that the Natural History Museum in Cromwell-road contains one of the finest and most complete libraries on natural history ever brought together. The collection had its origin in the several libraries attached to the departments of zoology, geology, mineralogy and botany while these were

in Bloomsbury. After the removal to South Kensington, the four departmental libraries were considerably supplemented by extensive purchases, for which a special vote was obtained from parliament. At the same time a 'general library' was formed to receive those works the subject-matter of which concerned more than one of the departments. The collection has been further increased by many generous and munificent donations and by exchange.

The library, of course, contains many very early books on natural history; and from these a selection has been made for the purpose of an exhibition intended to illustrate the origin and progress of the study of natural history up to the time of Linnæus. The exhibition, which occupies two table-cases in the Central Hall, has been arranged by Mr. B. B. Woodward, the librarian of the museum.

We are told that the study of natural history began with the dawn of civilization, and doubtless had its origin, so far as animals and plants were concerned, in the primitive observations of the hunter and of the medicine-man, or priest-physician, while the search for stone, and subsequently for metals, with which to fashion weapons and tools, served to draw attention to the nature and structure of the earth. That the hunters of the stone age were not unobservant of the quadrupeds they pursued is evinced by the carvings and the incised outline representations on bone, as well as by the remarkable pictures, drawn in manganese and red ochre, on the chalk walls of the caves in the Dordogne. Examples of the carvings and reproductions of these drawings are shown in the present exhibition. Turning to books proper, we may note a copy of the oldest popular natural history book, the 'Historia Naturalis,' or 'Historia Mundi,' of Pliny the elder, printed by J. de Spira's press at Venice in 1469. This was one of the first, if not the first, of natural history books printed. It presents an epitome of the state of Roman knowledge on the subject, and in this connection it is of interest to note that the number of known plants recorded in it is about 1,000. Mention may also be made of a copy of Vincent of Beauvais's 'Bibliotheca Mundi,' compiled by that learned Dominican at the instance of Louis IX. of France. This work is not only one of the earliest of encyclopedias, but the greatest of the middle ages. It was first printed at Strasburg about 1473.

The Royal Society is represented by a copy of the first volume of the *Philosophical Transactions*, the earliest publication of any scientific society. It was issued in monthly numbers, of which the first appeared in March, 1665, and for the most part deals with physics.

A special interest attaches to an edition of the 'Stirpium adversaria nova' of Pena and L'Obel, printed at Antwerp by Plantin and finished in England in 1570–1. It contains one of the earliest figures of the tobacco plant and an illustration of the method of smoking of the North American aborigines. The pipe is drawn as being somewhat straighter than the Atlantic coast ones generally were.

The earliest illustrations of the potato plant are seen in a work by Charles de Lécluse, the 'Rariorum Plantarum Historia,' printed at Antwerp in 1601. Lécluse traveled extensively in western Europe making collections, and wrote several books on the botany of the districts he visited. The figures of the potato plant in the work named are from drawings made by him in 1589 from actual specimens. The plant, we know, was growing in Italy in 1586, about which time it was also introduced into England.

Harvey's doctrine that every living thing came originally from an egg, afterwards expressed by the aphorism,' 'Omne vivum ex ovo,' is symbolized in the engraved title-page of the second edition of his 'Exercitationes de Generatione Animalium,' printed at The Hague in 1680. The original edition was issued in London in 1651.

Space will allow us only to mention briefly one or two other works in this extremely interesting exhibition. Note should be made of John Ray's greatest botanical work, the 'Historia Plantarum,' published at London in 1686, containing the description of some 6,900 plants in systematic order. The museum copy was the property of Sir Hans Sloane, and has

his manuscript notes, with the references to the places of the plants in his herbarium. Then there is a copy of the second edition of Robert Plot's 'Natural History of Oxfordshire' (Oxford, 1705), the first edition of which appeared in 1677. This work was the forerunner of the numerous 'County Histories' that have been subsequently issued.

Finally, attention may be drawn to the earliest figure and description of that flightless bird, the solitaire, in a book by the French traveler François Leguat, printed at London in 1708. The solitaire formerly inhabited the island of Rodriguez, and became extinct about the end of the eighteenth century.

STATISTICS OF EASTERN, STATE AND FOREIGN UNIVERSITIES.

IN an address before the University of Michigan, printed in the *Atlantic Monthly,* Dr. Henry S. Pritchett showed a table giving data in regard to six of the older private universities in the eastern states, six western state universities and six foreign universities, which is here reproduced:

OLDER PRIVATE UNIVERSITIES IN EASTERN STATES.

Name.	Date of Founding.	Number in Instructing Staff.	Number of Students 1904.	Annual Budget 1904.	Annual Cost to University Per Student.	Annual Cost to Student.
Harvard	1636	525	5,143	$1,572,540[1]	$306	$150
Columbia	1754	551	5,017	1,438,638	270	$150 to $250
Yale	1716	343	3,138	800,000	255	100 " 150
Pennsylvania	1791	325	2,838	685,000	241	150 " 200
Princeton	1756	109	1,374	460,863	335	150 " 160
Brown	1764	85	988	180,000	192	150
Total		1,938	18,498	$5,137,041		

WESTERN STATE UNIVERSITIES.

Name.	Date of Founding.	Number in Instructing Staff.	Number of Students 1904.	Annual Budget 1904.	Annual Cost to University Per Student.	Annual Cost to Student.
Michigan	1837	292	4,136	$746,000	$180	$10 to $45
Illinois	1868	402	3,594	800,000	223	free
Wisconsin	1848	227	3,342	700,000	209	free
Minnesota	1868	290	3,895	497,000[2]	128	$20 to $100
California	1868	283	3,400	945 000	279	e
Nebraska	1869	193	2,513	419,750	167	ree
Total		1,687	20,880	$4,107,750		

FOREIGN UNIVERSITIES.

Name.	Date of Founding.	Number in Instructing Staff.	Number of Students 1904.	Annual Budget 1904.	Annual Cost to University Per Student.	Annual Cost to Student.
Berlin	1807	504	13,782	$880,500	$ 64	small fees
Leipsic	1409	216	4,253	716,000	170	" "
Paris	1100	420	12,985	934,000	72	" "
Vienna	1384	431	6,205	464,000	76	" "
Bonn	1818	177	2,970	361,000	123	" "
Edinburgh	1583	205	2,971	469,000	158	$10 to $20 a course.
Total		1,953	43,166	$3,824,500		

[1] Omitting $875,575 in special gifts.

[2] Omitting $400,000 for buildings.

THE EIGHTEENTH SEASON OF THE MARINE BIOLOGICAL LABORATORY. 1905.

THE regular season for investigators opened June 1 and continued through most of September. During this period there were in attendance 71 investigators, of whom 63 occupied private rooms with an average period of attendance of about six weeks to two months.

Students receiving instruction were in session from June 28 to August 9, and the total attendance was 57, a much smaller number than in the years previous to 1903, owing to the raising of the standard of admission at that time. The work of collection of material was again under the charge of the curator of

the supply department, Mr. G. M. Gray, who had eight assistants during the busiest part of the season. Each investigator was supplied with his material on demand and the service gave great satisfaction.

For some years the necessity of a larger steamer has been felt and this year the laboratory chartered the steamer *Genevieve*, about 100 feet over all. The range of collecting expeditions was thus increased very materially and the work facilitated in many other ways. Another welcome addition to the equipment was a gasoline launch assigned to the supply department.

In the fall of 1904 the laboratory renovated and remodelled the interior of the old stone building known as the 'candle factory' and equipped it with heating apparatus and running salt water. It now forms the headquarters of the supply department, and two investigators' rooms are available for use at all seasons of the year.

The annual meeting of the trustees and corporation was held on August 8. Reports of the assistant director and treasurer showed a very satisfactory condition of the laboratory as to equipment and finances. Messrs. S. F. Clark, Charles Coolidge, C. R. Crane, T. H. Morgan, L. L. Nunn, John C. Phillips, Erwin F. Smith and E. B. Wilson were reelected trustees to serve until 1909, and Messrs. A. P. Mathews and H. S. Jennings were elected to fill vacancies in the board. Seventeen new members were elected to the corporation.

The following is the list of investigators who worked at the laboratory during the season:

I. ZOOLOGY.

1. *Occupying Rooms.*

Budington, Robert A., instructor in zoology, Wesleyan University, Conn.

Clapp, Cornelia M., professor of zoology, Mt. Holyoke College, South Hadley, Mass.

Colton, Harold Sellers, graduate student, University of Pennsylvania, Philadelphia, Pa.

Conklin, E. G., professor of zoology, University of Pennsylvania, Philadelphia, Pa.

Drew, Gilman A., professor of biology, University of Maine, Orono, Me.

Fielde, Adele M., New York, N. Y.

Foot, Katherine, 80 Madison Ave., New York, N. Y.

Gardiner, E. G., 131 Mt. Vernon St., Boston, Mass.

Glaser, Otto Charles, instructor, University of Michigan, Ann Arbor, Mich.

Goldfarb, Abraham J., graduate student, Columbia University, New York, N. Y.

Hargitt, C. W., professor of zoology, Syracuse University, Syracuse, N. Y.

Hargitt, George Thomas, instructor in biology, Syracuse High School, Syracuse, N. Y.

Jennings, H. S., assistant professor of zoology, University of Pennsylvania, Philadelphia, Pa.

King, Helen Dean, graduate student, Bryn Mawr College, Bryn Mawr, Pa.

Lambert, Avery E., instructor in biology, State Normal School, Framingham, Mass.

Lefevre, George, professor of zoology, University of Missouri, Columbia, Mo.

Lewis, Warren Harmon, associate professor of anatomy, Johns Hopkins University, Baltimore, Md.

Lillie, Frank R., associate professor of embryology, University of Chicago, Chicago, Ill.

Loeb, Leo, assistant professor of experimental pathology, University of Pennsylvania, Philadelphia, Pa.

Lombard, Guy Davenport, assistant instructor in histology, Cornell University, Ithaca, N. Y.

Lommen, Christian P., professor of biology, University of South Dakota, Vermilion, South Dakota.

McClellan, John H., graduate student, Harvard College, Cambridge, Mass.

McGregor, James Howard, lecturer in vertebrate zoology, Columbia University, New York, N. Y.

Morgan, T. H., professor of experimental zoology, Columbia University, New York, N. Y.

Morgan, Mrs. T. H., New York, N. Y.

Murbach, Louis, head of department of biology, Central High School, Detroit, Mich.

Putnam, Margaret, student, Bryn Mawr College, Bryn Mawr, Pa.

Reed, Margaret, graduate student, Columbia University, New York, N. Y.

Retzer, Robert, assistant in anatomy, Johns Hopkins University, Baltimore, Md.

Richardson, Harriet, Washington, D. C.

Shippen, L. P., graduate student, University of Pennsylvania, Philadelphia, Pa.

Snowden, Louise Hortense, graduate student, University of Pennsylvania, Philadelphia, Pa.

Smith, Grant, teacher of biology, Chicago Normal School, Chicago, Ill.

Stevens, Nettie Maria, Bryn Mawr College, Bryn Mawr, Pa.

Strobell, Ella G., New York, N. Y.

Strong, Oliver S., instructor in histology, Columbia University, New York, N. Y.

Strong, R. M., associate in zoology, University of Chicago, Chicago, Ill.

Tennent, David Hilt, associate in biology, Bryn Mawr College, Bryn Mawr, Pa.

Treadwell, Aaron L., professor of biology, Vassar College, Poughkeepsie, N. Y.

Wallace, Louise Baird, associate professor of zoology, Mt. Holyoke College.

Whitney, David Day, graduate student, Columbia University, New York, N. Y.

Wilson, Edmund B., professor of zoology, Columbia University, New York, N. Y.

Woodruff, Lorande Loss, instructor in biology, Williams College, Williamstown, Mass.

II. OCCUPYING TABLES.

Allabach, Lulu F., department of zoology and geography, State Normal School, Lockhaven, Pa.

Buckingham, Edith N., Radcliffe College, Cambridge, Mass.

Gregory, Louise H., graduate student at Columbia University, New York, N. Y.

Newman, Horatio H., instructor in zoology, University of Michigan, Ann Arbor, Mich.

O'Neil, Elizabeth Breading, instructor, Mt. Holyoke College, South Hadley, Mass.

Surface, Frank Macy, fellow in zoology, University of Pennsylvania.

Terry, Oliver P., assistant in physiology, St. Louis University Medical Department, St. Louis, Mo.

Worsham, Ernest Lee, tutor in biology, University of Georgia, Athens, Ga.

2. *Physiology.*

Brown, Harry Orville, assistant professor of pharmacology, St. Louis University.

Carlson, Anton J., assistant professor of comparative physiology, University of Chicago, Chicago, Ill.

Hyde, Ida H., professor of physiology, University of Kansas, Lawrence, Kansas.

Lillie, Ralph S., instructor in physiology, Harvard Medical School, Boston, Mass.

Lyon, Elias Potter, professor of physiology, St. Louis University, St. Louis, Mo.

Mathews, A. P., associate professor of physiological chemistry, University of Chicago, Chicago, Ill.

Meigs, Edward B., assistant in physiology, University of Pennsylvania, Philadelphia, Pa.

Packard, Wales H., assistant professor of biology, Bradley Polytechnic Institute, Peoria, Ill.

Sollmann, Torald, professor of pharmacology, Western Reserve University Medical Department, Cleveland, Ohio.

Spaulding, Edward G., preceptor in philosophy, Princeton University, Princeton, N. J.

3. *Botany.*

Andrews, Frank Marion, assistant professor of botany, Indiana University, Bloomington, Ind.

Dacy, Alice Evelyn, South Boston, Mass.

Davis, Bradley Moore, assistant professor of botany, University of Chicago, Chicago, Ill.

MacRae, Lillian J., teacher, South Boston High School, South Boston, Mass.

Stickney, Malcolm E., assistant professor of botany, Denison University, Granville, Ohio.

Wolfe, Jas. J., adjunct professor of biology, Trinity College, Durham, N. C.

Wylie, Robert Bradford, professor of biology, Morning College, Sioux City, Iowa.

Yamanouchi, Shigeo, fellow of the University of Chicago, Chicago, Ill.

SUMMARY—1905.

Students.

Course in zoology	27	
Course in life histories	14	
Course in physiology	7	
Course in botany	9	
	—	57

Investigators.

Zoology:		
Occupying rooms	43	
Occupying tables	8	
	—	51
Physiology:		
Occupying rooms	10	
Occupying tables	2	
	—	12
Botany:		
Occupying rooms	8	
	—	8
Total of students and investigators	128	
Deduct two names mentioned twice	2	
	—	126

Number of Institutions Represented.

By investigators	35	
By students	36	
	—	71

Colleges, Universities and Institutions

Represented.

By investigators	28	
By students	26	
	—	54

Schools and Academies Represented.

By investigators	7	
By students	10	
	—	17

RESEARCH SEMINARS AT THE MARINE BIOLOGICAL LABORATORY. SEASON OF 1905.

July 11. Dr. A. J. Carlson, 'Conduction in Nerves.'

July 13. Dr. A. P. Mathews, 'Precipitation of Colloids by Electrolytes.'

July 18. Dr. L. L. Woodruff, 'Life-Histories of Hypotrichous Ciliates.'

July 20. Dr. W. H. Lewis, 'Experiments on Correlative Embryology.'

July 25. Dr. Torald Sollmann, 'Filtration Phenomena in Dead Kidneys.'

July 28. Dr. C. W. Hargitt, 'Variations in the Genus *Aurelia*.'

August 2. Dr. H. S. Jennings, 'Behavior of Sea Anemones.'

August 8. Dr. O. C. Glaser, 'Amitosis in *Fasciolaria* Embryos'; 'Origin of Nettle Cells in Nudibranchs.'

August 10. Dr. Leo Loeb, 'The Growth of Tumors.'

August 15. Dr. E. P. Lyon, 'Geotropism in *Paramœcium*.'

August 17. Dr. E. G. Spaulding, 'Experimental Determination of Energy in the Segmentation of the Sea-Urchin's Egg.'

August 22. Mr. J. F. McClendon, 'Some Effects of Pressure on the Segmentation of the Eggs of Copepods.'

Dr. Louis Murbach, 'Marginal Bodies of *Gonionemus*.'

FRANK R. LILLIE.

THE NEW ORLEANS MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE permanent secretary of the association has received a certain number of letters from members who seem to have gained the impression that there is some doubt about the desirability of holding the meeting as announced in the city of New Orleans on account of the fact that there have been a number of cases of yellow fever in that city during the past few months. The permanent secretary has consulted members of the committee on the policy of the association and some of the leading members of the council and finds that the consensus of opinion is that the meeting should be held in New Orleans and that no change of plan should be considered. He has further corresponded with prominent yellow fever experts and sanitarians and has consulted the wishes of the people of New Orleans and the result is that it seems beyond all possible question that a meeting during convocation week in that city will be as safe as in any other city in the United States.

Surgeon-General Walter Wyman, of the Public Health and Marine Hospital Service, who has charge of the situation in New Orleans, assures the permanent secretary that there will not be the slightest danger in holding the meeting in New Orleans at the time specified. Such a thing as a case of yellow fever at that time is unprecedented and long before that time the last case will have received its final treatment.

Ex-Surgeon-General Sternberg, U. S. Army, a notable yellow fever expert, writes the permanent secretary under date of October 7, that the history of the prevalence of yellow fever in New Orleans makes it appear certain that there will be no danger to any one visiting that city at the time of the meeting of the American Association for the Advancement of Science, December 28, 1905.

President Craighead, of Tulane University, and the secretaries of the New Orleans Progressive Union, Board of Trade, Stock Exchange, Sugar and Rice Exchange, have all written letters voicing the same opinion and with enthusiastic cordiality renewing the invitation to the association to hold its meeting in New Orleans. It would have been a sore

disappointment to the people of New Orleans had the association expressed any strong doubt of the fulfillment of its promise to meet in that city.

Dr. J. H. White, in charge of the Public Health and Marine Hospital Service in New Orleans, states that it would be perfectly safe for the association to meet in New Orleans long prior to December 29.

The secretary of the New Orleans board of trade writes that the hospitality of the city will not in the least suffer from the occurrence of yellow fever during the summer, which has not been a strain on the financial resources of the community, since there was only a slight interruption in the free movement of business. He further makes the significant remark, under date of September 19:

> The advancement of science has taught our citizens a lesson how to guard against a recurrence of yellow fever and there is to-day less danger from that disease than from typhoid fever which at this time prevails in many eastern cities to an alarming extent.

He further says:

> The association could not meet in a city more hospitable, nor in a climate more salubrious and environments more pleasing. * * * The entertainments to be given will not be lacking in that enthusiasm and warmth for which our city is famous all over the United States. * * * The association will find that the outbreak of yellow fever has neither made us too poor, nor too sorrowful, to give a rousing reception to the American Association for the Advancement of Science.

A letter received September 25, from a prominent state scientific official, residing in Shreveport, who has recently gone to the state of Louisiana and is, therefore, not influenced by local pride, writes to the permanent secretary as a member of the association, expressing the opinion that not the slightest risk will be incurred by any member of the association and that the meeting could in fact be held in New Orleans at the date of writing (September 25) and the visitors would be in no more danger of contracting yellow fever than they would be in contracting smallpox in Chicago or typhoid fever in Washington or Philadelphia.

On the basis of these opinions and on the strength of his own opinion (and he has for some years been making a special study of the yellow fever mosquito) and by the advice of a majority of the committee on policy, the permanent secretary is now making arrangements for the meeting and will as soon as possible issue the preliminary announcement. The local arrangements have been delayed, but President Craighead, of Tulane University, has now returned to New Orleans and the committees will soon be appointed, so that the necessary details may be completed. An effort is being made to secure a one-fare rate for the round trip and the result of these negotiations as well as other facts will be published as soon as possible.

SCIENTIFIC NOTES AND NEWS.

THE exercises in connection with the installation of Dr. Edmund J. James, as president of the University of Illinois, on Tuesday, Wednesday and Thursday of last week, took place in accordance with the program already printed here, in the presence of a large assemblage of delegates from foreign and American universities. We hope to print in a subsequent issue the inaugural address of President James. Among the honorary degrees conferred were the following: Doctor of laws, Professor Thomas F. Holgate, acting-president of Northwestern University, and John B. Murphy, M.D., Chicago; doctor of science, Professor T. C. Chamberlin, of the University of Chicago; doctor of engineering, Octave Chanute, Chicago, and F. E. Turneaure, University of Wisconsin; doctor of

agriculture, Norman J. Colman, former secretary of agriculture, and Alvin H. Sanders, Chicago.

A scientific session of the National Academy of Sciences will be held at the Sheffield Scientific School, Yale University, New Haven, beginning Tuesday, November 14, 1905, at 11 A.M. A special stated session of the academy will be held on Wednesday, November 15, to consider any business that may come before the academy.

According to a despatch from Lindenburg, Prussia, where Emperor William went last week to attend the dedication of the Royal Prussian Aeronautical Observatory, the German ruler has conferred upon Mr. A. Lawrence Rotch, director of the Blue Hill Observatory the Order of the Red Eagle of the third class. The emperor at the same time presented the Prince of Monaco the great gold medal bestowed once a year for work in science.

Dr. Adolf von Baeyer, professor of chemistry at Munich, has been elected a foreign member of the Berlin Academy of Sciences. Dr. Baeyer will celebrate his seventieth birthday on October 31.

Dr. Hubert Lyman Clark, professor of biology at Olivet College, Michigan, who has recently been working with Dr. Alexander Agassiz in the study of sea urchins, will join the staff of the Harvard Museum of Comparative Zoology.

Mr. Percy W. Flint, of Charleston, S. C., has been appointed assistant chemist of the Pennsylvania Experiment Station in place of Mr. Arthur W. Clark, resigned.

The international Italian 'King Humbert Prize' of 2,500 francs for the most important contribution to orthopedic surgery has been assigned to Dr. Oscar Vulpius, of Heidelberg.

The Alvarenga prize for 1905 has been awarded to Dr. Chalmers Watson, of Edinburgh, Scotland, for his essay, entitled 'The Importance of Diet; an Experimental Study from a New Standpoint.' This prize is given by the College of Physicians of Philadelphia, and consists, each year, of the income of the bequest of the late Señor Alvarenga, amounting to about $180. The next award will be made July 14, 1906, provided that an essay deemed by the committee of award to be worthy of the prize shall have been offered. Essays intended for competition may be on any subject in medicine, but can not have been published. They must be typewritten, and must be received by the secretary of the college on or before May 1, 1906.

Sir Clements R. Markham, F.R.S., gave an address at Cambridge on October 19, introductory to the courses of instruction in geography.

The sixth annual Huxley memorial lecture of the Anthropological Institute, London, will be delivered on October 31, by Dr. John Beddoe, F.R.S., the subject being 'Color and Race.'

The three-hundredth anniversary of the birth of Sir Thomas Browne was celebrated by Yale University on October 19 with a commemorative address by Dr. Francis Bacon, under the auspices of the Modern Language Club.

Dr. Walter F. Wislicenus, editor-in-chief of the *Astronomischer Jahresbericht,* died on October 3 after a very brief illness. He was born November 5, 1859; was a member of the German transit of Venus expedition in 1882; assistant in the observatory of the University of Strassburg, 1883–89; instructor in the university since 1887, and professor since 1894. Since 1899, he has edited six volumes of the *Astronomischer Jahresbericht,* aggregating 3,764 octavo pages, embracing reviews of 13,874 separate books or articles.

Nature announces the deaths of the Rev. S. J. Johnson, the author of contributions to astronomy, and of Sir Edward H. Carbutt, a mechanical engineer.

The Boston *Transcript* estimates that the William M. Rice Institute for the Advancement of Literature, Science and Art, of Houston, Tex., organized to take under his will the residuary estate of William M. Rice, will receive from Rice's property in New York state $2,177,361.92. Since the murder of Mr. Rice his estate has been in litigation both in

New York and in Texas, a dispute over the probate of one will having been brought into court on the charge that the signature to it was a forgery. A controversy also arose on a claim against the estate for $2,000,000 by the executors of the estate of the wife, Elizabeth B. Rice. This was settled by the payment of $200,000. Nearly a million dollars have been paid in lawyers' fees and expenses incidental to the administration of the estate.

The department of anthropology, of the American Museum of Natural History, has received as a gift from Mr. T. Van Hyning, of the State Historical Department of Des Moines, Iowa, a series of grooved axes, celts and stone disks.

Mr. L. H. Farlow has recently presented the Peabody Museum with a large and rare collection of relics of Indian manufacture, collected on the northern Pacific coast—from Alaska to northern California.

Nature states that the Municipal Museum, at Hull, has recently acquired a valuable addition to its collection of local Roman and other remains. The specimens are principally of Roman date, and include more than 2,000 coins, nearly 100 fibulæ of a great variety of patterns, several dozen buckets, pins, dress fasteners, ornaments, strap ends, bosses, spindle whorls, armlets, spoons, beads and other objects. Among the fibulæ are two of exceptional interest, as they bear the maker's name upon them (Avcissa). There is also an extensive collection of pottery, including many vases, strainers, dishes, etc., in grey ware, as well as many fine pieces of Samian ware, several of which contain the potters' marks.

We learn from the *Boston Transcript* that the annual meeting of the Teachers' School of Science was held at the Twentieth Century Club, Boston, on October 20. Addresses were made by Henry L. Clapp, of the Putnam School; Arthur C. Boyden, of the Bridgewater Normal School; Mrs. Caroline F. Cutler, of the Wyman School, Jamaica Plain; and Miss Annette M. Blount, of the Wellesley Schools. The following officers were elected: President, Professor George H. Barton; first vice-president, Professor A. Lawrence Lowell; second vice-president, Miss Mary C. Mellyn; third vice-president, Miss Mary F. Thompson; auditor, Mr. Seth Sears; secretary and treasurer, Miss Cora S. Cobb.

Medical journals report that the second International Sanitary Conference of American Republics was held in Washington, D. C., beginning on October 10. Delegates from twelve South American republics, from the army and navy and from the United States Health and Marine Hospital Service were in attendance. Surgeon General Walter Wyman presided. The address of welcome on behalf of the government was made by Mr. Root, the secretary of state. Mr. Taylor, assistant secretary of the treasury, also welcomed the delegates on behalf of the Public Health and Marine Hospital Service. The response was made by Mr. Quesada, the Cuban minister.

It is reported that Dr. Max Reithoffer, professor at the Vienna Technical High School, has, jointly with the court watchmaker, Karl Morawetz, submitted to the common council of Vienna a plan for an electric system of clocks run by wireless electricity. They propose to furnish the chronometric and electric apparatuses, including clocks, to the city free of charge, and to make the trials. The city has only to furnish the current, the cable connections, etc., and give the use of suitable buildings. The common council has appropriated $600 for making experiments.

UNIVERSITY AND EDUCATIONAL NEWS.

Mr. Andrew Carnegie has offered $100,000 to Union College, for an engineering building, on condition that the institution raise a like amount for this purpose. Mr. Carnegie has also offered to give Smith College one half of $125,000 required for a biological laboratory.

Building A, the first of the initial group of seven structures that form the new Carnegie Technical Schools, in Pittsburg, Pa., has been opened with a class of 120 students, selected from more than six hundred applicants. The classes will be increased from time to time as the buildings are opened. The schools for apprentices and journeymen are to be opened next month, and the other mechanical depart-

ments are being pushed forward to early completion.

The *Boston Transcript* reports that the total enrolment of students in Harvard University, not including Radcliffe College and the Summer School, reckoned from October 7, is 3,865, as against 4,004 at a corresponding time last year. In Harvard College there are 1,896 students, which is 93 less than on October 7 last year. In the Lawrence Scientific School are registered 500, a decrease of 14. The Graduate School shows 364, an increase of 21, and the Bussey Institution has enlarged its numbers from 22 to 27, but these are the only two departments of the university in which there has not been a loss. In the Divinity School there are 34, a loss of 3; in the Law School 681, a loss of 24; in the Medical School 281, a loss of 8; and in the Dental School 82, which is 23 less than last year on the above date. It might be mentioned in connection with the Medical School that the entering class has 10 more students than in 1904, the first increase since a degree was required for admission.

Registration figures complete to October 20, for all departments of Cornell University, at Ithaca, are, according to the New York *Evening Post* as follows:

	1904.	1905.
Sibley College	1,040	1,078
Arts	648	693
Civil engineering	377	411
Law	213	219
Agriculture	178	216
Veterinary	104	88
Architecture	68	79
Medicine	82	57
Graduates	147	151
Total	2,857	2,992

The president of Tulane University announces the proposal to found a school of tropical medicine in connection with that institution.

At the last meeting of the corporation of Harvard University, as reported in the Boston *Transcript*, the resignations of the following instructors were accepted: A. B. Plowman, '02, instructor in botany; H. W. Hill, instructor in bacteriology; P. Hodge, assistant in physics, and A. K. Adams, '04, assistant in geology. Appointments were made for one year, as follows: L. D. Hill, '94, and E. R. Shepard, assistants in physics; M. R. Cohen, assistant in philosophy; R. Kent, assistant in geology; E. C. Froelich, '03, and H. N. Davis, '03, instructors in mathematics; A. C. Boylston, '03, R. F. Jackson, '03, B. S. Lucy, J. E. Zanetti, '06, C. M. Brewster, W. V. Green, W. C. Holmes, E. Mueller, G. N. Terzieff and L. H. Whitney, assistants in chemistry; G. S. Forbes, '02, lecturer on physical chemistry; J. G. Jack and D. A. Clarke, '04, instructors in forest botany; R. C. Hawley, instructor in forestry; H. N. Eaton, assistant in geology, and E. J. Sanders, assistant in meteorology and physiography.

The University of Maine opened on September 20 with 190 additions to its collegiate departments. Of these about 120 are regular freshmen. The following appointments have been made in the various scientific departments: J. S. Stevens, professor of physics, dean of the College of Liberal Arts; W. K. Ganong, acting professor of electrical engineering; A. C. Jewett, associate professor of mechanical engineering; G. E. Tower, professor of forestry; M. H. Bedford, instructor in chemistry; W. R. Ham, instructor in physics; T. M. Gunn, instructor in mechanical engineering; H. D. Carpenter, instructor in electrical engineering; A. W. Gilbert, instructor in agriculture; J. M. Bearce, tutor in physics; L. T. Ernst, assistant in horticulture; M. G. Leeds, assistant in the experiment station.

Mr. James H. Jeams, lecturer at Cambridge, has been made professor of applied mathematics at Princeton University.

Dr. George Ben Johnston, of the Medical College of Virginia, has been elected professor of surgery at the University of Virginia to succeed Dr. A. H. Buckmaster, resigned.

Dr. John Earnest Loncing, Harvard, takes the chair in chemistry at Hobart College, Geneva, N. Y., in place of Dr. Herbert Raymond Moody, who has gone to the College of the City of New York.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE ORIGIN OF SPECIES THROUGH ISOLATION.

For me, it is the chorology of organisms, that is to say, the study of all the important phenomena embraced in the geography of animals and plants, which is the surest guide to the study of the real phases in the process of the formation of species. (Moritz Wagner.)

IT is now nearly forty years since Moritz Wagner (1868) first made it clear that geographical isolation (räumliche Sonderung) was a factor or condition in the formation of every species, race or tribe of animal or plant we know on the face of the earth. This conclusion is accepted as almost self-evident by every competent student of species or of the geographical distribution of species. But to those who approach the subject of evolution from some other side the principles set forth by Wagner seem less clear. They have never been confuted, scarcely even attacked, so far as the present writer remembers, but in the literature of evolution of the present day they have been almost universally ignored. Nowadays much of our discussion turns on the question of whether or not minute favorable variations would enable their possessors little by little to gain on the parent stock, so that a new species would be established side by side with the old, or on whether a wide fluctuation or mutation would give rise to a new species which would hold its own in competition with its parent. In theory, either of these conditions might exist. In fact, both of them are virtually unknown. In nature a closely related distinct species is not often

quite side by side with the old. It is simply next to it, geographically or geologically speaking, and the degree of distinction almost always bears a relation to the importance or the permanence of the barrier separating the supposed new stock from the parent stock.

A flood of light may be thrown on the theoretical problem of the origin of species by the study of the probable origin of species with which we may be familiar, or of which the actual history or the actual ramifications may in some degree be traced.

In such cases, one of the first questions naturally asked is this: Where did the species come from? Migration forms a large part of the history of any species or group of forms. The fauna of any given region is made up of the various species of animals living naturally within its borders. The flora of a region is made up of the plants which grow naturally within its borders. Of all these, animals and plants, the inhabitants of most regions are apparently largely migrants from some other region. Some of them have entered the region in question before acquiring their present specific characters; others come after having done so. Which of these conditions apply to any individual case can generally be ascertained by the comparison of individuals along the supposed route of migration. Thus the Tahoe trout is clearly a migrant from the Columbia River, its separation apparently dating from the time when the former lake basin of Nevada (Lake Lahontan) found its drainage in the Columbia. We know that the present specific characters of this trout were assumed within its present range, because these traits are not found in any other trout along the supposed line of its migrations. On the other hand, we feel certain that the salmon of New England originated as a species in Europe. In extending its range from its primitive home, it has not undergone any material change or acquired any distinctive characters, while both in Europe and in America it has more or less modified landlocked variants.

The region from which a group of animals is supposed to be derived is spoken of as its center of dispersion.

Thus the various forms of trout, originally of marine origin, seem to have diverged from the Siberian region, eastward and westward. This region is, therefore, the center of dispersion of trout. In like manner the tanagers have their center of dispersion in South America; the humming birds also. The lemurs have their center of dispersion in Madagascar, and the cat tribe in tropical Africa.

In general, although not always, the original home of any group of animals will show more varied forms than those in any other region. There may be some representatives more highly specialized, more primitive forms are likely to be preserved, more degenerate forms may be developed, and if the type is represented by fossils, these also may exhibit a larger range of forms and characters than will be found in regions occupied through later migrations.

It is evident that the nature of any fauna bears an immediate relation to the barriers, geographical or climatic, that surround it. Whenever the free movement of a species is possible, this involving the free interbreeding of its members, the characters of a species remain substantially uniform.

Whenever free movement and interbreeding is checked, the character of the species itself is altered. This is the meaning of Coues's pregnant phrase: 'Migration holds species true; localization lets them slip.' In other words, free interbreeding swamps the incipient lines of variation, and this in almost every case. On the other hand, a barrier of any sort brings a certain group of individuals together. These are subjected to a selection different from that

which obtains with the species at large, and under these conditions new forms are developed. This takes place rapidly when the conditions of life are greatly changed so that a new set of demands are made on the species, and those not meeting them are at once destroyed. The process is a slow one, for the most part, when the barrier in question interrupts the flow of life without materially changing its conditions. But this is practically a universal rule: A barrier which prevents the intermingling of members of a species will with time alter the relative characters of the groups of individuals thus separated. These groups of individuals are incipient species and each may become in time an entirely distinct species if the barrier is really insurmountable.

In regions broken by few barriers, migration and interbreeding being allowed, we find widely distributed species, homogeneous in their character, the members showing individual fluctuation and climatic effects, but remaining uniform in most regards, all representatives slowly changing together in the process of adaptation by natural selection. In regions broken by barriers which isolate groups of individuals we find a great number of related species, though in most cases the same region contains a smaller number of genera or families. In other words, new species will be formed conditioned on isolation, though these same barriers may shut out altogether forms of life which would invade the open district.

Thus throughout the eastern United States, unbroken by important barriers, there is but one true species of chipmunk, *Tamias striatus,* and one species of shorelark (*Eremophila alpestris*). In California, broken by many barriers of various sorts, there are a dozen or more different kinds of chipmunks, species and subspecies. But in the eastern states the fauna at large is much greater, because many types of birds and other animals have found entrance there, forms which are excluded from California by the barriers which surround that region.

In the great water basin of the Mississippi many families of fishes occur and very many species are diffused throughout almost the whole area, occurring in all suitable waters. Once admitted to the water basin, each one ranges widely and each tributary brook has many species. In the streams of California, small and isolated, the number of genera or families is much smaller. Each species, unless running to the sea, has a narrow range, and closely related species are not found in the same river.

The fact last mentioned has a very broad application and may be raised to the dignity of a general law of distribution.

Given any species in any region, the nearest related species is not likely to be found in the same region nor in a remote region, but in a neighboring district separated from the first by a barrier of some sort.

The nearest relative of the Tahoe trout (*Salmo henshawi*) is the cut-throat trout (*Salmo clarki*), its parent form, which is found in the Columbia and Missouri, the two rivers interlacing at their fountain heads. The nearest relatives of the cut-throat are two forms apparently descended from it, *Salmo virginalis,* of the basin of Utah, and *Salmo stomias,* of the Platte. Next to the latter is *Salmo spilurus,* of Rio Grande, and then *Salmo pleuriticus,* of the Colorado. The latter in turn may be the parent of the Twin Lakes trout, *Salmo macdonaldi.* Always the form next away from the parent stock is onward in space across the barrier.

The nearest relative to almost any Hawaiian species of fish is found in Polynesia; that to any Polynesian species is

found on the East Indies. From the East Indies we find lines diverging to the Red Sea, to the Cape of Good Hope, to Japan, to Polynesia and Hawaii, to Australia and New Zealand. We, therefore, consider the East Indies the center of dispersion or primitive home for most types of tropical fishes. At the Isthmus of Panama the nearest relative of many species of fishes is found across the isthmus, in the West Indies. Thus the red snapper of Panama, *Lutianus colorado,* finds its analogue in the red snapper of the Caribbean Sea—*Lutianus aya.* The large black snapper of Panama, *Lutianus novemfasciatus,* finds its nearest relative in the Cubera of the Caribbean, *Lutianus cyanopterus.* The same is true of perhaps 300 other species at Panama, enough to show that the resemblance across the isthmus is not a matter of accident. The divergence between these separated forms dates apparently from the time, in the late Miocene, when the seas ceased to flow together across this isthmus.

Again, in the Atlantic, the nearest relative of the Allice shad of the north of Europe (*Alosa finta*) is the Thwaite shad (*Alosa rufa*) of farther south. Another near relative is the American shad (*Alosa sapidissima*) of our Atlantic coast. This again finds its nearest ally in the Gulf shad (*Alosa alabamæ*), and this once more in the Ohio shad (*Alosa ohiensis*).

Always the species nearest alike in structure are not found together, nor yet far apart, and always a barrier lies between. Where two closely allied forms are not found to intergrade they are called distinct species. If we find actual intergradation, the occurrence of specimens intermediate in structure, the term subspecies is used for each of the recognizable groups, thus connected.

Thus of the bluebird, *Sialia,* we have in America three main forms, the one boreal, found in northern and western mountain regions, blue above and below alike, known as *Sialia arctica.* Another form, blue above and brown below, inhabits the whole region east of the Rocky Mountains. This is *Sialia sialis,* the common bluebird of the east, 'with the sky on its back and the earth on its breast.' In the warmer parts of the mountain region, Texas to California and southward, is still another blue bird, much like the second, but darker in color and with a large patch of brown on the back as well as on the breast. This is *Sialia mexicana.* These three are considered as distinct species because there is no evidence that intergradations occur in any part of their range. One of these species, *Sialia mexicana,* has been split up into subspecies, and this is related to the fact that its range is crossed by barriers greater than those which check the movement of the others. The typical *Sialia mexicana* is found in Mexico. *Sialia mexicana bairdi* represents it in the Rocky Mountain region, and *Sialia mexicana occidentalis,* in the Pacific Coast states. A local form, *Sialia mexicana anabelæ,* is found on the mountain called San Pedro Martir, in Southern California. Along the border line between *Sialia sialis* and *Sialia mexicana,* in Arizona and Mexico, the eastern bluebird throws off shoots called *Sialia sialis azurea.*

Widely distributed across the United States and from southern Canada to Arizona, we have the yellow warbler, *Dendroica æstiva.* This bird is chiefly yellow, olive on the back with chestnut streaks on the sides, tail feathers colored like the body, and without the white spot on the outer feathers shown in most of the other types of wood warblers composing the genus *Dendroica.*

The yellow warbler throughout its range is very uniform in size and color. Its nearest relative differs in having a shade

less olive on the back and the brown streaks on the sides narrower. This form is found in the Sonoran region, and, as along the Rio Grande, it intergrades with the first; it is called a subspecies, *Dendroica æstiva sonorana*. Further south, in central Mexico, this form runs larger in size and is recorded as *Dendroica æstiva dugesi*. Northward, through to Alaska, we have an ally of the parent bird, but smaller and still more greenish. This is *Dendroica æstiva rubiginosa*.

In the West Indies the golden warblers migrate not from south to north, but from the shore to the mountains, and possibly in consequence of the less demand of flight, the wing is shorter and more rounded, while the tail is longer. As these forms do not clearly intergrade with those of the mainland, and, for the most part, not with each other, they are held to represent a number of distinct species, although doubtless derived from the parent stock of *Dendroica æstiva*. Some of these West Indian forms are relatively large, the wing more than five inches long, and the longest known of these, the type of the species for this reason, found in Jamaica, is called *Dendroica petechia*. On the island of Grand Cayman is a similar bird, a little smaller, *Dendroica auricapilla*. Of a deeper yellow than *petechia*, and equally large, is the golden warbler of the Lesser Antilles ranging from island to island, from Porto Rico to Antigua. This form, first known from St. Bartholomew, is *Dendroica petechia bartholemica*. A smaller bird, a little different in color, takes its place in the Bahamas. This is *Dendroica petechia flaviceps*.

In Cuba the golden warbler is darker and more olive, with other minor differences from the form called *bartholemica*, of which it may be the parent. This is *Dendroica petechia gundlachi*. A similar bird, but with the crown distinctly chestnut, is *Dendroica petechia aureola*, the golden warbler of the Galapagos and Cocos Islands, off the coast of Ecuador and Peru. Scattered over other islands are smaller golden warblers with the wing less than five inches long, and with the crown tawny red, as in *aureola*. These are known collectively as *Dendroica ruficapilla*, the type being from Guadeloupe and Dominica. More heavily streaked, with the crown darker in color, is the golden warbler of Cozumel, *Dendroica ruficapilla flavivertex*, and with very similar but with darker crown is *Dendroica ruficapilla flavida*, of the island of St. Andrews. Always the nearest form lies across the barrier, and among these forms the chief barrier is the sea. With a darker chestnut crown is *Dendroica ruficapilla rufopileata*, of the island of Curaçao, and still darker bay is the crown of *Dendroica ruficapilla capitalis*, the golden warbler of the Barbadoes.

Still other golden warblers exist, with the chin and throat chestnut as well as the crown. One of these, olive green on the back, is *Dendroica rufigula*, of Martinique. The others are more yellow. One of these, with the sides heavily streaked, inhabits the isthmus region, *Dendroica erythachoides*, called a distinct species, because no intergradations have been made out. Another more faintly streaked replaces it on the Atlantic coast from Yucatan to Costa Rica, *Dendroica bryanti*, while the Pacific coast, from Sinaloa to Costa Rica, has another form, with still fainter markings, *Dendroica bryanti castaniceps*. An extreme of this form with the throat and breast tawny, but not the crown, is found in Jamaica again and is known as *Dendroica eoa*. In this case, which is one typical of most groups of small birds, the relation of the species to the barriers of geography is so plain as to admit of no doubt or question. Given the facts of individual fluctuation and of heredity, it is manifest that while natural selection may

produce and enforce adaptation to conditions of life, the traits which distinguish species bear little relation to utility. The individuals which, separated from the main flock, people an island, give their actual traits to their actual descendants, and the traits enforced by natural selection differ from island to island. If external conditions were alike in all the islands the progress of evolution would perhaps run parallel in all of them, and the only differences which would persist would be derived from differences in the parent stock. As some difference in environment exists, there is a corresponding difference in the species as a result of adaptation. If great differences in conditions exist, the change in the species may be greater, more rapidly accomplished, and the characters observed will bear a closer relation to the principle of utility.

Doubtless wide fluctuations or mutations in every species are more common than we suppose. With free access to the mass of the species, these are lost through interbreeding. Isolate them as in a garden or an enclosure or on an island, and these may be continued and intensified to form new species or races. Any horticulturist will illustrate this.

At the risk of becoming tedious we must continue these illustrations. The contention is not that species are occasionally associated with physical barriers, which determine their range, and which have been factors in their formation. It may be claimed that such conditions are virtually universal. When the geographical origin of a species can not be shown it is because the species has not been critically studied, from absence of material or from absence of interest on the part of naturalists, this showing itself often in a semi-contemptuous attitude of morphologists and physiologists towards species mongers and towards outdoor students of nature generally. In a few cases, a species ranges widely over the earth, showing little change in varying conditions and little susceptibility to the results of isolation. In other cases, there is some possibility that saltations, or suddenly appearing characters, may give rise to a new species within the territory already occupied by the parent form. But these cases are so rare that in ornithology, mammalogy, herpetology, conchology and entomology, they are treated as negligible quantities. In the distribution of fishes the same rules hold good, but as the material for study is relatively far less extensive and less perfectly preserved than with birds and insects, we have correspondingly less certainty as to the actual traits of species and subspecies, and the actual relation of these to the intervening barriers.

The American genus *Zonotrichia* comprises the group of streaked finches known as white crowned sparrows. Most of these agree in their grayish brown coloration, streaked with darker brown, with two black stripes on the crown of the head, the wings with two white bars and tail without white feathers. The wings and tail are long, the bill small, and there is little else to separate them from the great body of streaked sparrows, amidst which the white-crowned stand as among the largest in size.

In most of the group the crown of the head is whitish between the two black stripes. In one group of these there is no yellow on the head, these being the typical white crown sparrows, *Zonotrichia leucophrys*. The common form breeds in the Rocky Mountain region and northeastward to Labrador. It has a black patch or stripe before the eye. Northwestward, from Montana to Alaska, these sparrows have the space before the eye whitish. These are *Zonotrichia leucophrys gambeli*. Southward, coastwise, from Vancouver Island to Monterey, California, the edge of the wing becomes yellow and we have *Zonotrichia leucophrys nuttalli*.

East of the Rocky Mountains, in the same region as the typical *leucophrys,* we have the white-throated sparrow, with yellow in front of the eye, and some other differences. This is *Zonotrichia albicollis.* It does not cross the mountains and no subspecies are recognized, unless indeed the species *Zonotrichia leucophrys* be one of the offshoots. Two other species, distinct so far as we know, are recognized, *Zonotrichia coronata,* the golden crowned sparrow, breeding in Alaska, and the stately Harris sparrow, *Zonotrichia querula,* of the interior plains, migrating from Missouri and Minnesota to the Saskatchewan region. In this species the top of the head is black, with stripes of either white or yellow.

Besides these differences of color, each species has some slight peculiarity of form. *Zonotrichia albicollis,* for example, having a rounded wing and *Zonotrichia coronata* a longer tarsus than the other species.

In a discussion of the origin of certain species of chickadee Joseph Grinnell[1] makes the following observations:

It is *isolation*, either by barriers or by sufficient distance to more than counterbalance inheritance from the opposite type that seems to me to be the absolutely essential condition for the differentiation of two species, at least in birds. A strong argument in support of this conviction is that we never find two 'subspecies' breeding in the same faunal area, and no two closely similar species, except as can be plainly accounted for by the invasion of one of them from a separate center of differentiation in an adjacent faunal area (example, *Parus rufescens* of the West Coast fauna, and *Parus gambeli* of the arid Sierras meet in the Siskiyou mountains). * * *

The extremest intra-competition does not ensue until after further discrimination is impossible. * * *

Two species of approximately the same food habits are not likely to remain long evenly balanced in the same region. One will crowd out the other: the one longest exposed to local conditions and hence best fitted though ever so slightly will survive to the exclusion of any less favored invader. However, should some new contingency arise, placing the native species at a disadvantage, such as the introduction of new plants, then there might be a fair chance for a neighboring species to gain a foothold, even ultimately crowding out the native form. For example, several pairs of the Santa Cruz chickadee (*Parus rufescens barlowi*) have taken up their abode in the coniferous portion of the arboretum at Stanford University, while the plain titmouse prevails in the live oaks of the surrounding valley.

* * * The greatest rate of reproduction is presumably where the species finds itself best adapted to its environment, and this is also where the death rate is least, unless an enemy rapidly multiplies so as to become a serious check. * * * In wide ranging species subcenters arise. * * * From each of these new centers of distribution, there will be a yearly radiating flow of individuals into the adjacent country so as to escape intra-competition at any one point.

[1] *Auk*, July, 1904, p. 372.

Not long since the writer addressed to certain leading ornithologists of the United States a circular letter, as given below. Certain typical answers to this letter are appended, all agreeing in general with the proposition stated above.

In considering the proposition that species in general arise in connection with geographic or topographic isolation, will you kindly answer briefly the following questions?

1. Do two or more well founded subspecies ever inhabit [breed in] the same region? If so, give examples.

2. If so, how do you explain the fact?

3. Would you regard a form as a 'subspecies' if coextensive in range with the species with which it intergrades?

4. Are there cases where two species inhabiting exactly the same region are closely related, and more closely than any other species is in either one? If so, give examples.

LEONARD STEJNEGER.

Before answering the four questions contained in your letter of February 21, just received, allow me to make a few general remarks.

I suppose that by inhabit you mean propagate, since many migrating subspecies spend part of their time in the territory of the other subspecies. It may probably be necessary to further qualify the word *propagate* by adding *simultaneously,*

since it is thinkable at least that the subspecies might have become 'isolated' in the same locality by adopting different times of propagating. Might not such cases occur among fishes? I have also a sort of suspicion that it may occur, or may have occurred earlier, in some migratory birds on both sides of the equator. Altogether, I wish to be very reserved in my answers and I would have you understand an *obligato* 'so far as I know' added to all of them. The fact is, that the records when it comes to distinguish between the propagation habitat and the general habitat of the species are so defective that no fully reliable conclusions can be drawn from them.

1 and 2. I know of no well-founded subspecies propagating simultaneously in the same locality (I would avoid the word region as not restricted enough).

As a matter of fact I can not well conceive of two subspecies propagating simultaneously in the same locality except perhaps during a short time under the following supposition as shown by an example:

Suppose the so-called *Lanius major* of Siberia and *Lanius excubitor* were only subspecifically distinct, *i. e.*, that they had not yet developed beyond a certain degree of character stability along the original territorial line separating them somewhere in Central Asia (a supposition I do not admit, though I do not deny the possibility, the data at hand being inconclusive). Now suppose both species extended their range westward, *L. excubitor* to central Europe thence north to the Scandinavian peninsula *viâ* Denmark, while *L. major* pushed northwestward over Finland to northern Norway (and these suppositions I believe are correct!). Suppose further that the breeding ranges of both subspecies met and finally overlapped, say in some localities in Finmarken (and there are indications that they do, though the records are anything but satisfactory). The chances are, of course, that in these localities the two subspecies would mix, but for some time at least it is probable that a certain percentage of both might continue to breed pure alongside of each other. Though all this is mere speculation it is probably legimate to carry the supposition a step further. Finmarken is the most extreme end of the range of both (supposed) subspecies, it is then not unnatural to conclude that in the specimens meeting there the characters might have become so fixed that the two forms would react on each other as two distinct species, though at their original dividing line they might still remain in the imperfectly differentiated stage.

3. No, as a rule not. But *if* as I hinted above the isolation were one of time of spawning, for instance, concomitant with which a certain amount of structural differentiation had taken place, then I can conceive of such a state as indicated in question 3, viz., that the ranges (in space) of both subspecies might be coextensive.

4. There are a few cases where *apparently* two species inhabiting exactly the same region (these terms restricted as above), are *apparently* more closely interrelated than to any other. As an example I may quote two Japanese birds, *Cettia cantans* and *C. cantillans*, the chief and possibly the only difference being the constantly greater size of the former. Yet we are told that they occur in exactly the same localities. I used the word *apparently* above because in the first place the *exact* relationship of the two species is not ascertained, and in the second, the records of the breeding ranges of both are not as complete as might be desired. That the two forms are distinct and do not intergrade seems certain. Altogether I do not pretend to understand the case.

There are a few other similarly puzzling cases, for instance, that of *Phyllopneuste borealis* and the so-called subspecies *xanthodyas* but apart from the fact that in this case the latter is not coextensive with the former only occupying part of the territory, the records are so incomplete and defective the chances are the puzzle may be easily solved when all the facts are known.

The case of various forms for crossbills might also be cited. In their case it almost looks as if each band is kept isolated by their gipsy-like habits, though it is just possible that they may have evolved different breeding periods or different food making them dependent on the latter for the selection of their temporary breeding locality. At any rate, the isolation does not seem to be geographical or topographical.

I hope I have been able to make my standpoint clear, viz., that two geographical subspecies can not propagate in the same locality (except in rare cases illustrated by the *Lanius* example), but that there are other kinds of isolation—or possibly better: segregation, which—though more rarely—may produce subspecies—eventually species when the incomplete differentiation has become complete,—capable of living side by side in the same locality.

WILLIAM BREWSTER.

I have no knowledge based on personal experience that two well-marked subspecies of the same

species of bird ever *breed* in the same region. It is, of course, by no means unusual for two forms subspecifically isolated to occur together during migration or in their winter homes.

If I understand your fourth question rightly I should say that there are a good many known cases of species more closely related to one another than to other species occurring (in breeding) in the same region. The best examples of this that occur to me are the Allen and Least flycatchers, the blue-winged and the golden-winged warblers (these two species interbreed fairly and their hybrid offspring is *fertile*), and the Swainson's and Bicknell's thrushes. All these breed in New England and the species mentioned in pairs breed to the same covers. I think that in England excellent examples may be found among the very closely isolated warblers belonging to the family Turdidæ and the family Sylviinæ.

I certainly should be loath to believe that two birds which were subspecies of the same species could breed, at least in the same area.

C. HART MERRIAM.

Your letter making inquiries as to coextensive ranges of subspecies of the same species, and so on, reached me some little time ago, but owing to pressure of other matters I have not been able to reply earlier. My answer to questions 1, 2 and 3 was no, from the first. I felt a little uncertain about the fourth question, and have spent some time in running over lists of birds and mammals in order not to make a mistake. After careful consideration I must answer this question in the same way as the others, as I fail to find any two closely related species inhabiting exactly the same region.

JOSEPH GRINNELL.

In reply to your recent circular, I offer the following:

In birds several subspecies may occur in the same region in *winter*, because of their seasonal scattering. But I know of not even one case where two subspecies *breed* in precisely the same region. I have run down two alleged cases—both proved irrelevant.

My criterion for diagnosis as subspecies is—two forms connected by a continuous series of intergrades uninterruptedly covering the interlying ground. If a geographic hiatus exists (as in island races), even though intermediates may *apparently* bridge over the difference in mean characters, I call the two forms *species*. I can see no difference between species and subspecies, except an average one in *degree* of differentiation; and that fluctuates with personal opinion (*e. g.*, note A. O. U. rulings from year to year!). I am about ready to deny the value of trinomials in nomenclature on this account. Call all distinguishable groups of individuals *species*, as Sharpe tries to do in his 'Hand-List of Birds.' I know of no case where two species inhabiting the same region are 'closely' related, or even more closely related than any other species is to either one.

I believe in *isolation* either by barriers, or by sufficient distance to more than counterbalance invading inheritance from the opposite extreme (geographically) as being one *essential* factor in the differentiation of species.

LEVERETT MILLS LOOMIS.

1, 2. I know of no instance.

3. No.

4. I do *not* recall a case among the Tubinares, particularly in the closely related species in *Oceanodroma*, *Puffinus*, *Æotrelata;* of course 'exactly the same region' in these birds would be the breeding grounds.

CHARLES H. GILBERT.

In attempting to reply to your circular letter concerning subspecies, I am limited by the fact that well marked subspecies are hardly known in ichthyology. Unless the term shall be finally applied to such local forms as the fresh-water sticklebacks, or to the minutely variant form characteristic of different tributaries of the same hydrographic basin, I see no probability of the subdivisions of fishes beyond the species. I can not answer your questions, therefore, on the basis of personal experience with subspecies, a fact which prevents my views from having any weight. I may, however, venture the following suggestions:

The answer to all your questions will depend upon the definition given the terms 'range' and 'region.' It might well be found, for example, that two subspecies of song sparrow would occupy the Santa Clara Valley, one confined to the tule swamps, the other to the dry uplands. That two subspecies should have coextensive range and live in the same habitat within the range, would seem impossible from the accepted definition of subspecies. I refer here to the older definition of subspecies, for many well known zoologists have recently adopted the view that subspecies are determined by the small amount of divergence rather than the ascertained fact of intergradation. To those who so hold, anything would be possible with subspecies which would be possible with species.

I know of no example under question 4.

WALTER KENRICK FISHER.

1. In *Melospiza cinerea pusillula* Ridgway and *M. c. santæcrucis* Grinnell we have two conspecific races inhabiting the same region but occupying different habitats.

2. *Santæcrucis* (a distinguishable but very closely related race to *cooperi* Ridgway, of the San Diegan-Los Angeles district), dwells in the valleys and on lower mountain slopes of the Santa Cruz Mt. peninsular, and as far south as southern Monterey Co., California. It is common along the fresh-water streams emptying into both sides of the south arm of San Francisco Bay. But *M. c. pusillula* breeds only on the marshes, among the Salicornia. Its range is consequently surrounded by that of *M. c. santæcrucis*. East of Palo Alto one can stand by nests of *santæcrucis* and be within shouting distance of many nests of *pusillula*. Yet the two races never, during the breeding season, encroach upon one another's domain. The *M. c. samuelis* of Baird occupies the salt marshes along the northern arms of San Francisco Bay. So far as known it does not intergrade with *M. c. pusillula*.

3. Not if coextensive in habitat throughout a large part of the range of both forms. If intergradation was proved beyond a doubt it might be shown that one race had encroached upon another over part of its range. Intergradation has been satisfactorily established in so few cases that one would be justified in calling such forms species.

4. The only case I can recall is that of *Empidonax hammondi* and *E. wrighti*, which are practically indistinguishable out of hand. They breed commonly in the high Sierra Nevada and over western North America. So far as genetic relationship is concerned there is a probability that *hammondi* may be a descendant of the eastern *minimus* stock, while *wrighti* may be nearer *E. fulvipectus* (S. Mexico).

I have written out the only cases I know of which will bear on your questions. The song sparrow case is easily explained by a difference of habitat. The word 'region' is of course susceptible to many interpretations. In California where zones are wonderfully juxtaposed in a sort of nature's crazy-quilt one has to be unusually specific as to locality. Birds labeled Santa Clara Valley, for instance, would considerably mislead one unacquainted with the region, if he happened to receive specimens of two subspecies of song sparrow.

Referring to the land snails of the island of Oahu (Hawaii), Alfred Russel Wallace quotes from Rev. J. T. Gulick the statement that the island has in its wooded portions about 175 species of land-shells represented by 700 or 800 varieties.

> We frequently find a genus represented in several successive valleys by allied species, sometimes feeding on the same, sometimes on allied plants. In every case the valleys that are nearest to each other furnish the most nearly allied forms, and a full set of the varieties of each species presents a minute gradation of forms between the more divergent types found in the more widely separated localities.

Similar conditions are recorded among the land snails in Cuba and in other regions. In fact, on a smaller scale, the development of species of land and river mollusks has everywhere progressed on similar lines with that of birds and fishes. Many other illustrations of the same sort, drawn from almost all groups of animals, have been given by Dr. Moritz Wagner, whose epoch-making work has not received from writers on organic evolution the attention it deserves. Perhaps one cause of this neglect is found in Wagner's persistent opposition to the theory of natural selection and his insistence on isolation and migration as virtually the only factors in species forming. But to recognize isolation as practically a necessary condition in the subdivision of species need not necessarily eliminate or belittle any other factor. Isolation is a condition, not a force. Of itself, it can do nothing. Species change or diverge with space and with time; with space, because geographical extension divides the stock and brings new conditions to part of it; with time, because time brings always new events and changes in all environment.

One of the most remarkable cases of group evolution is that of the song birds of Hawaii, constituting the family of Drepanidæ. In this family are about forty species of birds, all much alike as to

general structure, but diverging amazingly from each other in the form of the bill, with, also, striking differences in form of body and in plumage. In almost all other families of birds the form of bill is very uniform within the group. It is correlated with the feeding habits of the bird, and these in all groups of wide range become nearly uniform within the limits of the family. With a great range of competition, each type of bird is forced to adapt itself to the special line of life for which it is best fitted. But with many diverging possibilities and no competition, except among themselves, the conditions are changed, and we find Drepanidæ in Hawaii fitted to almost every kind of life for which a song bird in the tropics may possibly become adapted.

In spite of the large differences to be noted, there can be little doubt, as Dr. Hans Gadow, Mr. H. W. Henshaw and others have shown, of the common origin of the Drepanidæ. A strong peculiar goat-like odor exhaled in life by all of them affords one piece of evidence pointing in this direction. There is, moreover, not much doubt that the whole group is descended from some stock belonging to the family of honey-creepers, Cœrebidæ, of the forest of Central America. Each of the Hawaiian islands has its species of Drepanine birds, some olive green in color, some yellow, some black, some scarlet and some variegated with black, white and golden. The females in most cases, like the young, are olive green. On each island, most of the species are confined to a small district, to a single kind of thicket or a single species of tree, each species being especially fitted to these localized surroundings. With the destruction of the forests some of these species are already rare or extinct. With high specialization of the bill they lose their power of adaptation. In each of the several recognized genera there are numerous species, mostly thus specialized and localized, relatively few species being widely distributed throughout the islands.

Most primitive of all, least specialized and most like the honey creeper ancestry, is the olive green *Oreomystis bairdi* of the most ancient Island of Kauai. This bird has a small straight bill, not unlike that of the slender-billed sparrow. It is said to be the most energetic and ubiquitous of the group, feeding on insects on the trunks of trees. If we assume that *Oreomystis,* or some other of the genera with short and slender bills, represents the original type of Drepanidæ, we have two lines of divergence, both in directions of adaptation to peculiar methods of feeding.

Next to *Oreomystis,* on the one hand we have *Loxops* and *Himatione,* with the bill pointed, a little longer than in *Oreomystis,* and slightly curved downwards. The species, red or golden, of these two genera are distributed over the islands, each on its own mountain or in its own particular forest. *Vestiaria,* another genus, remarkable for its beautiful scarlet plumage, has the bill very much longer and strongly curved downward. *Vestiaria coccinea,* the iiwi of the islands, lives among the crimson flowers of the ohia tree (*Metrosideros*) and the giant lobelia, where it feeds chiefly on honey, which is said to drop from its bill when shot. According to Mr. S. B. Wilson, the scarlet sickle-shaped flowers of a tall climbing plant of *Strongylodon lucidus* found in these forests 'mimic in a most perfect manner both in color and shape the bill of the iiwi' so that the plant is called nukuiiwi (bill of the iiwi).

The next genus, *Drepanis,* has the sickle bill still further prolonged, forming a segment of a circle, and covering nearly 50 degrees. *Drepanis pacifica,* one of the

species, has the bill forming about one fourth of the total length. The species of this genus, black and golden in color, were very limited in range, and are now nearly or quite extinct. Still another group with sickle bills, *Hemignathus*, diverges from *Vestiaria* in having the upper mandible only very long and decurved, the lower one being relatively short, straight and stiff. The numerous species are mostly golden-yellow in color. Some or all of them use the lower mandible for tapping the trees, after the fashion of woodpeckers, while with the long and flexible upper one they reach into cavities for insects or insect larvæ or suck the honey of flowers. The group contains long-billed forms like *Hemignathus procerus* of Kauai, in which the bill is more than one fourth the total length of the bird, and short-billed forms like *Hemignathus* or *Heterorhynchus olivaceus* of Hawaii. In the short-billed forms the two mandibles are most unlike; the upper very slender, much curved and about one fourth the length of the rest of the body, the lower mandible half as long and thick and stiff. These birds feed chiefly on insects in the dead limbs of the koa trees in the mountain forests.

Mr. S. B. Wilson remarks:

> Nature has shown great symmetry in regard to the species of this genus (*Hemignathus*) to be found in the Sandwich Archipelago, three of the main islands having each a long-billed and a short-billed form.

This of course is most natural. Both long-billed forms (*Hemignathus*) and short-billed forms (*Heterorhynchus*) have spread from the island where they were originally developed to the other islands, each changing as it is isolated from the main body of the species and subjected to natural selection under new conditions.

With the genus *Hemignathus* and its aberrant section, *Heterorhynchus*, the forms with slender bills reach their culmination.

Going back to the original stock, to which *Oreomystis bairdi* is perhaps the nearest living ally, we note first a divergence in another direction. In *Rhodacanthis*, the bill is stout like that of the large finch, not longer than the rest of the head, and curved downward a little at the tip. The species of this genus feed largely on the bean of the acacia and other similar trees, varying this with caterpillars and other insects. The stout bill serves to crush the seeds. In *Chloridops*, the bill is still heavier, very much like that of a grosbeck. *Chloridops kona* is, according to Mrs. Robert Perkins, a dull sluggish solitary bird and very silent, its whole existence may be summed up in the words 'to eat.' Its food consists of the fruit of the aaka (bastard sandal tree), and as they are very minute, its whole time seems to be taken up in cracking the extremely hard shells of the fruit, for which its extraordinarily powerful bill and heavy head have been developed.

> The incessant cracking of the fruits, when one of these birds is feeding, the noise of which can be heard for a considerable distance, renders the bird much easier to get than it otherwise would be. Its beak is always very dirty with a brown substance adhering to it which must be derived from the sandal-nuts.

In *Psittirostra* and *Pseudonestor* the bill suggests that of a parrot rather than that of a grosbeak. The mandibles are still very heavy, but the lower one, as in *Heterorhynchus*, is short and straight, while the much longer upper one is hooked over it. *Pseudonestor* feeds on the larvæ of wood boring beetles (*Clytanus*) found in the koa trees (*Acacia falcata*), while the closely related *Psittirostra* eats only fruits, that of the ieie (*Freycinetia arborea*), and the red mulberry (*Morus sapyrifera*) being especially chosen. In all these genera

there is practically a species to each island, except that in some cases the species has not spread from the mountain or island in which we may suppose it to have been originally developed.

There are a few other song birds in the Hawaiian Islands, not related to the Drepanidæ. These are derived from the islands of Polynesia and have deviated from the original types in a degree corresponding to their isolation.

In the case of the Drepanidæ it seems natural to conclude that natural selection is responsible for the physiological adaptations characteristic of the different genera. Such changes may be relatively rapid, and for the same reason they count for little from the standpoint of phylogeny. On the other hand, the non-useful traits, the petty traits of form and coloration which distinguish a species in Oahu from its homologue in Kauai or Hawaii, are results of isolation. These results may be analyzed as in part differences in selection with different competition, different food and different conditions, and in part to hereditary difference due to the personal eccentricities in the parent stock from which the newer species was derived.

In these and in all similar cases we may confidently affirm: The adaptive characters a species may present are due to natural selection or are developed in connection with the demands of competition. The characters, non-adaptive, which chiefly distinguish species do not result from natural selection, but from some form of geographical isolation and the segregation of individuals resulting from it.

The origin of races and breeds of domestic animals is in general of precisely the same nature. In traveling over England one is struck by the fact that each county has its own breed of sheep, each of these having its type of excellence in mutton, wool, hardiness or fertility, but the breeds distinguished by characters having no utility either to sheep or to man.

The breeds are formed primarily by isolation. The traits of the first individuals in each region are intensified by the in-breeding resulting from segregation. Natural selection preserves the hardiest, the most docile and the most fertile; artificial selection those which yield the most wool, the best mutton and the like. The breed once established, artificial selection also tends to intensify and to preserve its non-adaptive characteristic marks. The more pride the breeders take in their stock, the more certain is the preservation of the breed's useless peculiarities.

Taking the common middle-wool sheep of southern England, the following key to some of the visible race traits was made while driving along the county roads.

a. Rams and ewes with short white horns. Dorsetshire.
aa. No horns.
  b. Face and ears black.
    c. Skin below tail black. Hampshire.
    cc. Skin below tail white. Devonshire.
  bb. Face and legs tawny: no black. Southdown.
  bbb. Face and ears white: ears erect. Cheviot.

Not one of these characters has the slightest intrinsic or physiological value. Each of them would disappear in a few generations of crossing, and in each breed the virtues of wool or of flesh exist wholly independently of these race marks.

Analogous to these race peculiarities of sheep are the minor traits among the men of different regions. Certain gradual changes in speech are due to adaptation, the fitness of the word for its purpose, analogous to natural selection. The non-adaptive matters of dialect find their origin in the exigencies of isolation, while languages in general are explainable by the combined facts of migration, isolation and the adaptation of words for the direct uses of speech.

In the animal kingdom generally we may say: whenever a barrier is to some extent traversable, the forms separated by it are liable to cross from one side to the other, thus producing intergradations, or forms more or less intermediate between the one and the other. For every subspecies, where the nature of the variation has been carefully studied, there is always a geographical basis. This basis is defined by the presence of some sort of a physical barrier. It is extremely rare to find two subspecies inhabiting or breeding in exactly the same region. When such appears to be the case, there is really some difference in habit or in habitat; the one form lives on the hills, the other in the valleys; the one feeds on one plant, the other on another; the one lives in deep water, the other along the shore. There can be no possible doubt that subspecies are nascent species, and that the accident of intergradation in the one case and not in the other implies no real difference in origins.

Of all branches of science, we may say that the one most advanced in its development, most nearly complete in its conclusions, is that of the systematic study of American birds. No other group of naturalists has made such extensive studies of individual or of group variations as the ornithologists who have dealt with American birds. And for this reason, and on account of the excellence of the preserved material with which they have to deal, the students of our birds have thoroughly understood the relation between species-making and geographical distribution, the persistence of group variation and the origin of species.

While the processes of natural selection may be always at work destroying those individuals not fitted to their surroundings, and accentuating the adaptation of the species through those which survive, and while sometimes natural selection may work with great acceleration where conditions are widely changed, yet it is clear that the characters by which one species is actually known from the next are rarely traits of utility. Such traits bear no visible relation to the process of natural selection, using that term in a strict sense.

For example, we may compare the species of American orioles constituting the genus *Icterus*. We may omit from consideration the various subspecies, set off by the mountain chains, and the usual assemblage of insular forms, one in each of the West Indies, and confine our attention to the leading species as represented in the United States.

The orchard oriole, *Icterus spurius*, has the tail all black, the head all black, the lower parts chestnut, and the body relatively small, as shown by the average measurements of different parts. In the hooded oriole, *Icterus cucullatus*, the head is orange, the throat black, and the wings are black and white. This species, with its subspecies, ranges from Southern California over much of Mexico. Our other orioles have the tail black and orange. In the common Baltimore oriole, *Icterus galbula*, of the east, the head is all black, and the outer webs of the wing coverts are black and white. In the equally common bullock oriole, *Icterus bullocki*, of the California region, the head is partly yellow, and the greater wing coverts are mostly black. The females of all the species are plain olivaceous, the color and proportions of parts varying with the different species, while in the males of each of the many species black, white, orange and chestnut are variously and tastefully arranged. Each species again has a song of its own, and each its own way of weaving its hanging nest.

That which interests us now is that not one of these varied traits is clearly related

to any principle of utility. Adaptation is evident enough, but each species is as well fitted for its life as any other, and no transposition or change of the distinctive specific characters or any set of them would in any conceivable degree reduce this adaptation. No one can say that any one of the actual distinctive characters or any combination of them enables their possessors to survive in larger numbers than would otherwise be the case. One or two of these traits, as objects of sexual selection or as recognition marks, have a hypothetical value, but their utility in these regards is slight or uncertain. It is customary at present to look with disfavor on sexual selection as a factor in the evolution of ornamental structures, and the psychological reality of recognition marks is yet unproved, though not at all improbable.

It may be noted, in passing, that the prevalent dull yellowish and olivaceous hues of the female orioles of all species is clearly of the nature of protective coloration.

Professor Vernon L. Kellogg has shown statistically that certain specific characters among insects have no relation to the process of selection. Among honey bees the variation in venation of the wings and in the number and character of the wing hooks is just as great when the bees first come from their cells as in a series of individuals long exposed to the struggle for existence.

Among ladybird beetles of one species (*Hippodamia convergens*) 84 different easily describable 'aberrations' or variations in the number and arrangement of the black spots on the wing covers have been traced. These variations are again just as numerous in individuals exposed to the struggle for life as in those just escaped from the pupal state. In these characters there is, therefore, no rigorous choice due to natural selection. Such specific characters, without individual utility, may be classed as indifferent, so far as natural selection is concerned, and the great mass of specific characters actually used in systematic classification are thus indifferent.

And what is true in the case of the orioles is true as a broad proposition of the related species which constitutes any one of the genera of animals or plants. All that survive are well fitted to live, each individual, and therefore each species fitted to its surroundings as the dough is to the pan, or the river to its bed, but all adaptation lying apparently within a range of the greatest variety in non-essentials. Adaptation is the work of natural selection: the division of forms into species is the result of existence under new and diverse conditions.

To the general rule that closely allied species do not live together there exist partial exceptions. It may be well to glance at some of these, for no rule is established until its exceptions are brought into harmony with the phenomena which illustrate the rule.

The most striking case of this sort known to us is that of the Pescado Blanco of the volcanic lakes of Mexico, these constituting the genus *Chirostoma* in the family of Atherinidæ.

In the large lake of Chapala in central Mexico, tributary to the Rio Lerma, one species, *Chirostoma estor,* has been known for years. It is a pale, translucent fish of elongate form, about fifteen inches in length, with very delicate flesh, and it is much appreciated as a food fish under the local name of 'Pescado Blanco de Chapala.' In a recent visit to that region, the Pescado Blanco was found to be abundant in the lake, but to the great surprise of the writer, in the same catch of the net were found

under the same general guise of size and appearance some half a dozen distinct but closely related species of Pescado Blanco. In each case the different species most nearly related seemed to be found together, an exception to the rule otherwise almost universal among animals and plants. Later explorations of Dr. Seth E. Meek in this and other lakes confirmed and magnified this anomaly. The genus *Chirostoma* is confined to the lakes of the tablelands of Mexico. It includes three groups or subgenera: *Chirostoma* proper, green in color and with firm, smooth scales; *Lethostole*, with smaller scales, rough edged, the body white or translucent, and *Eslopsarum*, of smaller species, also white, but with still larger scales, larger than in *Chirostoma* or *Lethostole*. The species were found to be grouped as follows:

Lake Chapala.	(*Lethostole*) *estor.*
	(*L*) *ocotlanæ.*
	(*L*) *lermæ.*
	(*L*) *sphyræna.*
	(*L*) *lucius.*
	(*L*) *promelas.*
	(*L*) *grandocule.*
	(*L*) *chapalæ.*
	(*Eslopsarum*) *labarcæ.*
	(*E*) *bartoni.*
Lake Patzcuaro.	(*L*) *estor.*
	(*L*) *grandocule.*
	(*Chirostoma*) *humboldtianum.*
	(*E*) *patzcuaro.*
	(*E*) *attenuatum.*
Lake Zirahuen.	(*L*) *estor.*
	(*E*) *zirahuen.*
Lake Chalco (City of Mexico).	(*C*) *humboldtianum.*
	(*E*) *jordani.*
Aguas Calientes.	(*E*) *arge.*

No data exist for the explanation of this peculiar case of distribution. It is possible that *C. humboldtianum* of the lakes of Mexico represents the ancestral type, that the groups *Eslopsarum* and *Lethostole* have diverged from it, and that the numerous species of the last-named type in the large lakes, Chapala and Patzcuaro, have been formed by mutations in the sense of the use of the word by de Vries. But it is possible that these species have been formed by isolation, and that species thus formed have invaded the territory of other species. The shifting of the shores of these volcanic lakes and of the hydrographic basins to which they belong is among the possible causes to be considered.

Another curious case of the occurrence in one locality of similar species is found in the genus *Eviota* of the family of Gobiidae or gobies.

Eviota contains very minute fishes of the coral reefs, translucent green in color, plain or blotched with orange and marked with black spots. One species one and a half inches long (*Eviota abax*) is found in Japan, and one an inch long (*Eviota personata*) in the West Indies. The other species are all less than an inch in length, some of them but half an inch, perhaps the smallest of all vertebrate animals. One of these, *Eviota epiphanes*, is found in crevices in the coral reefs of Hawaii. Another, *Eviota miniata*, is recorded from Guam. All the remaining species, including those most closely related, are known only from the crevices of coral heads in Samoa. Most of the known specimens, hundreds in all, were obtained by the writer and his associates in Apia and Pago Pago. Our native assistants would dive for these coral masses, and on cracking them, the little fishes would be found in their channels and interstices. In Samoa the following species occur: *Eviota zonura*, *E. smaragdus*, *E. prasites*, *E. afelei*, *E. sebreei*, *E. pruinosa*, *E. herrei*, *E. distigma*. It would seem as if these species could not have had a geographic origin in the ordinary sense, for they are all grouped

together in the same neighborhood. It is, however, possible that the isolation of a part of the reef or even of that of a single coral head might in long periods serve the same purpose.

Enneapterygius is a genus of blennies in size and distribution closely parallel with *Eviota*. It contains species of moderate size found in the Gulf of California, in New Zealand, the Red Sea and Japan. In these same coral heads, species of this genus also occur, all of them extremely minute, much smaller than their relatives in other waters, and scarcely larger than the species of *Eviota*, among which they live. These minute fishes are mostly red in color, sometimes partly black. Again one species (*Enneapterygius atriceps*) is found in the Hawaiian reefs, and again six species (*E. minutus, E. hemimelas, E. hudsoni, E. tusitalæ, E. cerasinus* and *E. tutuilæ*) live together in the coral heads of Samoa.

The more usual distribution of a group of closely related fishes may be shown by the group of silver-fin minnows, the section *Erogala*, in the genus *Notropis* among the fishes.

All these are small minnows, with large scales, and with the dorsal fin marked by a large black blotch on its last rays above. This fin in the males is tipped with a broad stripe of silvery or milk-white pigment, and sometimes also shaded with bright red, orange or blue, very conspicuous in the breeding season.

The simplest, most primitive and most widely distributed form is *Notropis whipplii* of the Mississippi Valley. Near to this in the Upper Tennessee is *Notropis galacturus*. In the Ozark range is *Notropis camurus*. Farther south a black spot appears at the base of the tail. This marks *Notropis notatus* in the Rio Colorado of Texas, *Notropis venustus* in the Rio Sabinal, *Notropis cercostigma* in Pearl River, and *Notropis stigmaturus* in the Alabama. On the eastern part of its range, the nearest relative of *Notropis whipplii* is *Notropis analostanus* of the Potomac. Near to this is *Notropis niveus* of the North Carolina rivers and *Notropis chloristius* of the Santee. Other variants from these are *Notropis eurystomus* of the Chattahoochee, *Notropis xænurus* of the Allamaha, *Notropis cæruleus, callistius* and *trichroistius* of the Alabama and Black Warrior, the last two with scarlet on the dorsal. Finally come the most specialized extremes, *Notropis pyrrhomelas* of the Santee and *Notropis hypselopterus* of the Mobile. Each southern river has one or more species of this type, and the streams of Georgia have been invaded from the north and from the west, the two types meeting in the basin of the Alabama.

In the little group of minnows called *Hydrophlox*, another section of the genus, *Notropis rubricroceus*, and its allied species, scarlet, black and golden, are distributed in precisely the same fashion, and about the same number of species are developed. Those found in the Mississippi River have the widest range of distribution and the least specialization in their traits. Those in the clear waters of the southern slope of the Blue Ridge are most intensely colored, most specialized in the traits, and show the narrowest range in distribution.

If fishes were as easily preserved, measured and examined as birds, and if they were studied by as many keen eyes, we might find perhaps that each of these species is again broken up into races or subspecies, their traits determined in some degree by their individual parentage, in larger part by the local selection they have undergone in their diverse waters and surroundings. This is certainly probable in

the case of fresh-water fishes, but with marine fishes there is greater freedom of migration, the species are perhaps largely of more ancient origin and intergrading forms are much more rarely recognized.

The degree of fulness and accuracy in the recognition of subspecies marks the degree of progress in any branch of systematic or of faunal zoology and botany. It is the tyro who, as Linnæus[2] suggests, sees the problems of geographical distribution in the large. It is the master who follows step by step the footprints of the Creator in the molding and distribution of life. DAVID STARR JORDAN.

STANFORD UNIVERSITY.

[2] "Tyro fit classes: magister fit species."

SCIENTIFIC BOOKS.

The Waterlilies: A Monograph of the Genus Nymphaea. By HENRY S. CONARD, Senior Harrison Fellow in Botany, University of Pennsylvania. Published by the Carnegie Institution of Washington. 1905. Pp. xiii + 279. 4to, 30 plates and 82 figures in the text.

This thick volume, which is listed as 'Publication No. 4' of the Carnegie Institution of Washington, appeared several months ago, and attracted immediate attention on account of its excellence of paper, type, presswork and plates. In the style of its publications the institution is setting a high standard which can not but favorably affect scientific publication throughout the country. The plates are from drawings (some colored) and photographs, which have been very faithfully reproduced. The text-figures, while largely outlines, are also well done, adding greatly to the value of the work.

Turning now to the text, we find a chapter given to a historical sketch, followed by another devoted to structure, still another to development, one to physiology. The central chapter devoted to taxonomy is the longest and most important, and this is followed by brief discussions of distribution, hybrids and garden varieties, culture and uses and an extended bibliography. From the preface we learn that 'nothing like a complete synopsis of the waterlilies has hitherto been put before the English-speaking world,' and indeed it appears that it is more than eighty years since the last complete treatment in any language, *i. e.,* De Candolle's in the 'Prodromus' (1824). The present work is the result of studies undertaken by the author in the botanical garden and laboratories of the University of Pennsylvania, supplemented by living and preserved specimens and material from many sources, including that in the herbaria in Kew, British Museum, Linnean Society, Berlin, Munich, etc.

It would be pleasant to summarize, or quote from the historical chapter in which many interesting facts are brought together in very readable form. Likewise there is much of interest and importance in the chapter on structure, which includes gross and minute anatomy, and in the next chapter on the physiology of the plants (including a discussion of the cause of the opening and closing of the flowers), but there is no space here for this. The reader is recommended to peruse the interesting chapters for himself.

The chapter on taxonomy is the one of most general interest to the ordinary reader. The author prefers the name *Nymphaea* to *Castalia* for the genus, reserving the latter for one of the subgenera. The species are arranged under two principal groups, viz., (I.) *Nymphaeae Aprocarpiae* (with carpels free from one another at the sides) and (II.) *Nymphaeae Syncarpiae* (with carpels completely fused with one another at the sides). Two subgenera are recognized in the first group, *Anecphya,* with but one species, *N. gigantea* (Australian), and *Brachyceras,* with twelve species, *N. elegans* (Texas and Mexico), *N. ampla* (tropical and subtropical America) *N. flavo-virens* (probably Mexican), *N. stellata* (southeast Asia), *N. coerulea* (Africa), *N. micrantha* (West Africa), *N. heudelotii* (Africa), *N. ovalifolia* (East Africa), *N. calliantha* (Africa), *N. capensis* (South Africa), *N. sulfurea* (Africa), and *N. stahlmannii* (Africa). In the second group the subgenus *Castalia* in-

cludes seven species, *N. mexicana* (Florida, Texas, Mexico), *N. tetragona* (eastern Europe, Asia, North America to Australia), *N. fennica* (Finland), *N. candida* (northern Europe and Asia), *N. alba* (Europe and North Africa), *N. odorata* (eastern United States), and *N. tuberosa* (central United States); the subgenus *Lotos,* four species, *N. lotus* (Egypt), *N. zenkeri* (Africa), *N. pubescens* (East Indies), and *N. rubra* (East Indies); the subgenus *Hydrocallis,* ten species, *N. amazonum* (tropical America), *N. rudgeana* (tropical America), *N. blanda* (Guatemala), *N. lasiophylla* (Brazil), *N. gardneriana* (Brazil), *N. jamesoniana* (western South America and Porto Rico), *N. stenaspidota* (Brazil), *N. tenerinerva* (Brazil), *N. oxypetala* (Equador) and *N. gibertii* (Paraguay). It is noteworthy in this day when almost every monographer finds a lot of new species in his material, as a matter of course, that Doctor Conard describes but one new species, viz., *N. ovalifolia,* and a few new varieties. A second new species, *N. zenkeri,* by Professor Gilg, of Berlin, is here printed for the first time, although the name has been used for some time in European herbaria.

The closing chapter, mostly devoted to cultural directions, can scarcely be read without making one want to undertake the growth of some of these interesting plants. Beginning with such suggestions as 'the care of them is very simple; the pond or tank may be only a large bucket or a half barrel,' Doctor Conard proceeds to more and more elaborate suggestions, some of which can not fail to tempt his readers to make a beginning in their cultivation.

The author is to be congratulated upon having made such a notable contribution to botanical science. CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

American Insects. By VERNON L. KELLOGG, Professor of Entomology and Lecturer on Bionomics in the Leland Stanford Jr. University. New York, Henry Holt & Co. 1905. Pp. 674.

In recent years a good many text-books or general works on the insects of America have been published. Several of these have been limited to special fields, such as 'The Butterfly Book' and 'The Moth Book,' by Dr. Holland, and 'The Insect Book,' by Dr. Howard, the latter a companion book to Dr. Holland's volumes, covering the other orders of insects excepting the Coleoptera. Several text-books have, however, included the whole subject, among which may be mentioned Comstock's 'Manual for the Study of Insects,' Packard's 'Text-book of Entomology,' and volumes relating to insects more particularly in economic relations, such as Smith's 'Economic Entomology,' and Sanderson's 'Insects Affecting Staple Crops.' The best foreign work in English covering the general subject is Dr. Sharp's two volumes on insects in the Cambridge Natural History series, which remains the best work of its kind so far produced. Dr. Sharp's work, however, applies to the insects of the world. The volume prepared by Professor Kellogg, as indicated in the title, is limited practically to American insects, and is somewhat broader in scope than any of the American text-books so far published. The insect field in all its relations is so vast that it becomes a very difficult problem to include it even in a general way in a single volume, but Professor Kellogg has accomplished this very satisfactorily, on the whole.

As indicated in his preface:

> This book is written in the endeavor to foster an interest in insect biology on the part of students of natural history, of nature observers and of general readers; it provides in a single volume a general systematic account of all the principal groups of insects as they occur in America, together with special accounts of the structure, physiology, development and metamorphoses, and of certain particularly interesting and important ecological relations of insects with the world around them. Systematic entomology, economic entomology, and what many be called the bionomics of insects are the special subjects of the matter and illustration of the book.

The structure and physiology of insects is gone into in considerable detail in the opening chapter. Metamorphosis and systematic classification of insects are rather briefly considered. The different orders and families of insects are then taken up seriatim, from the

lowest to the highest, and the structural characteristics, habits and transformations are discussed in some detail for the more important representatives of each family. The work includes also supplementary chapters on the relation of insects to flowers and the fertilization of plants, color and pattern and their uses, including also a discussion of protective resemblance, warning colors, mimicry, etc., and a chapter on the relation of insects to disease, discussing in some detail the relation of mosquitoes to malaria, yellow fever and filariasis. An appendix covers the general subject of collecting and rearing insects. The scope of the volume, therefore, is seen to be a very broad one. In some respects it reminds one of Dr. Sharp's excellent work, but falls short of the English publication in the character of the illustrations and in the general dignity of style. Professor Kellogg's work is designated apparently to arouse popular interest in the subject, and is somewhat uneven in style, varying from popular statement with an occasional indulgence in the rhapsody of the nature lover, to very technical and scientific matter.

The illustrations are very copious, including some 812 text figures and 13 plates, the latter mostly color-process reproductions from photographs. There are also many purely decorative figures. The text illustrations serve their purpose very well in supplementing the descriptive matter, but are of very unequal quality. Many of them are original, the work of Miss Mary Wellman; but many others are reproductions from standard European and other works and from the publications of various experiment station and other entomologists of this country. Very often old figures have been thus copied where much more accurate and better ones could have been substituted. Much of this reproduction and copying has evidently been done by means of photo-processes, and the result is rather unfortunate, especially in the case of the smaller figures, which are often mere blotches of black or at least have lost much of the structural detail which they originally possessed. The colored plates are most of them very good, and will enable the ready recognition of the insects portrayed. The excuse is doubtless a valid one that, in a work as numerously illustrated as is this, the question of expense renders impracticable the careful preparation of all the illustrations.

Synoptical tables or keys to the different orders and families of insects are given throughout the book which will enable the student, with the aid of the illustrations, to form at least a rough classification of his collections.

An examination of the subject matter of the different chapters shows considerable care in getting the main facts and putting the information into semipopular language which may be readily understood by the student. While necessarily very largely a compilation, personal studies of the author in various special subjects greatly enrich the volume and give it freshness and originality. A great deal of interesting matter is thus contained in the volume, and the information given is reliable and correct as a whole. One notes, however, occasional errors of statement, evidently resulting from haste in the preparation of the work or careless compilation from original sources. For example, in the discussion of the fig insect, the Blastophaga is stated to have been imported directly from Asia Minor to California, when, in point of fact, the successful importations were from Algeria. In the discussion of luminosity of insects the matter is given a final status which is far from warranted by present knowledge of this interesting phenomenon. In the nomenclature the author has not followed the latest information, but in this particular he is perhaps justified, owing to the uncertain status of insect nomenclature and the frequent changes which are taking place, especially in the names of different genera. Some of the names employed can not, however, be excused on these grounds, and perpetuate old errors which have long been corrected in modern literature. The volume has no list of illustrations, but has a very full and useful index. The minor defects noted detract little from its real value, and Professor Kellogg's volume will be welcomed as one of the best general text-books on the subject covered. C. L. MARLATT.

The Educative Process. By WILLIAM CHANDLER BAGLEY. New York, The Macmillan Co. Pp. xix + 358.

As an attempt to organize the theory and practise of education in accordance with modern scientific thought and the results of psychological and genetic investigations, this book is well worthy of a review in SCIENCE.

In the view here presented, man is distinguished from other animals not only by his greater capacity to profit by his own experience, but especially by his ability to profit by the experiences of others transmitted to him through social habits and language. Education is the process by means of which the individual acquires experiences that will function in rendering more efficient his future action. Formal education includes the modifying influences, the control of which is consciously assumed either by the individual himself or by some educative agency, such as the home, church or school. The school is most important from the scientific point of view because its influence can be systematized and directed and the results determined.

Many of the principles of education are the same whatever the aim. The true aim of education may best be described as social efficiency. To be socially efficient a man must (1) pull his own weight, (2) interfere as little as possible with the effort of others, (3) consistently and persistently further progress.

Apperception is the reading of meaning into sense impressions and its chief law is 'The unifying of sense impressions into concrete experiences is accomplished through the adjustments to which the sensations themselves give rise.' The instincts of self preservation and of race preservation are the bases for the lower order of apperceptive systems, while those of the higher order are determined largely by acquired experiences.

Active attention and work must take the place of passive attention and play. The great work of the school is to produce this result and thus cause the instinctive and the near to be subordinated to the intellectual and remote. Hence education is largely a battle against nature. It should not, however, merely require certain activities, but it should develop needs that will demand the acquisition of experiences that will be beneficial in mature life.

Experiences take the form of unconscious habits or of conscious judgments; the first should be unchangeable, the second adaptable. The judgments may be either practical or conceptional. A concept is an apperceptive system made explicit. There is danger of too much dealing with symbols before concepts are developed by experience. Ready-made instead of reasoned judgments are used a great deal. Organization is the important thing in conceptional judgments.

The stages of child development are a transition stage from six to eight, a formative stage from eight to twelve and the adolescent stage from twelve to eighteen.

Formal discipline in the sense of the generalization of a habit is not possible, but ideals may be carried over from one field of effort to another. The chief purpose of education is to develop high ideals. An ideal must be emotional as well as intellectual, and it is high as it is abstract, social, remote. Values of studies are classed as utilitarian, conventional, preparatory, theoretical, sentimental.

In the actual work of teaching, instincts need not development, but utilization, transformation or elimination. Not only should children be given models, but they should be led to admire them. Imitation starts processes and habits are formed by trial and error. Abstract teaching should lead to abstract judgments, not to more concrete.

Judgments may be given children ready made (the indirect method) or the child may be placed under conditions that will impel him to form them himself (the direct method). The indirect method is the principal one in the elementary schools.

The media of intellectual transmission are oral discussion, books and graphic representation, and of emotional transmission, literature, pictorial and plastic art and music and oratory.

Inductive development lessons are valuable though they have limitations, but deductive development lessons are equally important while the study lesson, the recitation lesson,

the drill, the review and the examination lessons have each an important place.

Such, with an additional chapter on the 'Hygiene of Instruction,' are the main thoughts of the book very briefly summarized. It is evident that this is a broad systematic treatise far in advance of the traditional pedagogical work on theory and practise. It gives promise of a body of knowledge founded on the established principles of biology, sociology, psychology, child study and educational practise, that may soon be designated as a science of education without any apologies.

The biological and psychological aspects of education are most emphasized, and the treatment of education reduced to its lowest terms in the earlier chapters is admirable. Hobhouse on genetic psychology and Hall on child study are his favorite authorities, while on general psychology most of the leading psychologists of the day are referred to and quoted. His facts and principles are, therefore, generally reliable.

A very noticeable, though minor, error in his psychology, is shown in his statement that marginal vision is now of no use to man. The most fundamental defect in his early formulation of the foundations of the science of education is his failure to recognize the significance of other instincts than those concerned directly in self and race preservation. Man with his adaptive instinct of play, curiosity and imitation, and his regulative instincts of morality and religion, to say nothing of his social, collective, constructive, dramatic, expressive and other instincts so much stronger than in animals, is naturally a learning, language forming, socially organizing animal. The right utilization of these instincts is the keynote of modern education instead of the old idea of the teacher as battling against nature which is expressly endorsed in chapter VI. by this author. Later he recognizes some of these instincts, but he nowhere gives them their true place as powerful springs of action by the proper utilization of which much of the war against nature in education may be charged to the wise direction and regulation of natural activities of children.

In another respect the book is very unsatisfactory to the writer and certainly not in harmony with present educational movements. This is in his emphasis upon the indirect method of giving readymade judgments and of teaching by means of symbols. He admits the value of learning by experience and the artificial character of most school education, but yields so completely to the old school idea that in discussing media of instruction he omits to mention objects themselves (though in another place he discusses the use of objects, museums and excursions). At the present time when the best teachers are making great advances in rendering education less artificial through the more extensive and efficient use of objects and manual activities of all kinds, it is very disappointing to have a work that is so up to date in most respects fail not only in contributing something to this desirable advance, but to even pass it by as of little significance.

In one other respect the author's position is reactionary and in the light of present day thought and investigation untenable. This is shown in his endorsement of the absurd idea that the study of grammar rather than practise in seeing, hearing and using correct language is the proper method of learning to use good language forms. In this connection he holds that generally the conscious focusing of the mind upon each step is necessary to the rapid, efficient formation of habits. This is true in a large measure in adult, analytic and synthetic intellectual activities but not at all true of the lower order of intellectual and manual habits, especially of children, in whom the stages of analysis and synthesis are undifferentiated. In such cases the attempt to analyze and focalize on each step retards seriously the formation of habits. If children had to learn to walk, talk, control their bodies, etc., by the method of consciously focusing upon each step in those processes, many more years than are now required would be necessary to a much less perfect establishment of those habits. Even with older children, if the game of ball had to be learned by the method of focusing on each phase of the process, success in catching, batting, etc., would probably take much more of the boys'

time than it now does by the natural method. The most pernicious and untenable application of this idea appears when he claims that a child's attention should be focused upon the exact mistake he has made in previous repetitions.

In spite of these and some other less important mistakes and misplacements of emphasis, the book is a fresh, stimulating and generally correct organization of the principles of education.

WILBUR S. JACKMAN.

The Study of Chemical Composition. By IDA FREUND, Staff Lecturer and Associate of Newnham College. Cambridge, University Press. 1904. 8vo. Pp. xvi + 650.

This book presents an account of the method and historical development of the study of chemical composition. The initial discoveries forming the basis of the modern views of the composition of bodies are described, and the methods by means of which further experimental facts bearing upon the subject were obtained are clearly set forth. The historical development of the important laws is traced by showing how these grew from the study of certain classes of phenomena. In the course of this presentation many well-chosen quotations from classical original articles, including actual experimental data obtained, are given in sufficient detail to enable the reader to form an idea as to the degree of accuracy attained in the experiments which are of special consequence. Though the historical method of treatment has been adopted, no attempt has been made to secure such completeness or proportion as to deserve the name of history. The aim has been to describe only the most vital discoveries, and to do this thoroughly, rather than to dwell upon a greater number of facts.

A carefully written introduction of thirty pages devoted to a discussion of the method of inductive sciences prefaces the nineteen chapters in which the subject matter is treated. The first eight chapters deal with theories of combustion and the composition of bodies by weight. Here the work of Lavoisier, Dalton, Richter, Berthollet, Proust, Stas, Morley and others is described. Chapter nine presents the views concerning the constitution of matter held prior to 1800, and the following chapter deals with Dalton's atomic theory. Chapters eleven to thirteen relate to the combination of gases by volume, the work of Avogadro and Cannizzaro, and the molecular hypothesis. After detailing the discovery of Dulong and Petit in chapter fourteen, the subjects of isomorphism, periodic law, valency and isomerism are treated in the chapters following, and the book is fittingly closed with a final chapter setting forth the modern views concerning the ultimate constitution of matter and the genesis of the elements.

Throughout the book, facts and theories have been sharply and clearly separated from each other, a matter of vital importance in a treatise of this nature. The treatment is concise, clear and conservative, yet none the less interesting. The book can be heartily recommended to students of physical science and others desiring a reasonably condensed presentation of the existing views of chemical composition. Like the other volumes of the Cambridge Physical Series, the book is well printed.

LOUIS KAHLENBERG.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist, with the exception of the *American Journal of Science,* the oldest of the American scientific periodicals, announces a change in its editorial management. Dr. William McMichael Woodworth, who has so acceptably filled the position of editor-in-chief since 1898, retires and his place is taken by Dr. Glover M. Allen, the secretary of the Boston Society of Natural History. All correspondence intended for the editorial department should be directed to *The American Naturalist,* Cambridge, Mass.

THE October issue of the *Journal of Nervous and Mental Disease* opens with a report by Dr. Frank R. Fry of a case of cerebral tumor which presented some puzzling symptoms which led to the belief that the tumor was located in the left cerebellum, whereas the autopsy discovered it occupying the greater part of the site of the left inferior

frontal convolution. A paper by Dr. John Punton follows, treating of mysophobia, with a report of a case, and emphasizing the close relation which exists between the so-called neurasthenias and insanity. Dr. Theodore A. Hoch's paper on acute anterior poliomyelitis, begun in the previous number, is concluded, with an exhaustive bibliography, and Dr. William W. Graves contributes a short paper on anesthesia associated with hyperalgesia sharply confined to the areola-nipple area of both breasts, which his experience leads him to consider as a pathognomic and practically constant stigma in hysteria.

We learn from the *British Medical Journal* that the publication of a quarterly periodical, to be called the *Journal of Tropical Veterinary Science*, has been undertaken by Messrs. H. T. Pease, principal of Lahore Veterinary College; F. S. H. Baldry, professor of sanitary science, Punjab Veterinary College, and R. E. Montgomery, assistant imperial bacteriologist, Imperial Bacteriological Laboratory, Muktesar, U. P. Each number will, as far as possible, consist of original articles of scientific interest, with reviews and extracts from current literature. Nothing of a personal or political nature will appear in the journal. Amongst the subjects to be dealt with in the forthcoming numbers, for which arrangements have already been made, will be a series of articles on the anatomy, physiology, and pathological conditions of the camel and the elephant; the intestinal and other parasites of animals; the biting flies and the ticks of India, together with their importance in the transmission of disease. The first number will appear on January 1, 1906. The publishers are Messrs. Thacker, Spink and Co., Calcutta.

DISCUSSION AND CORRESPONDENCE.

CYANIDE OF POTASSIUM.

To the Editor of Science: Recently when at Minas Prietas, Sonora, at the cyanide plant of Charles Butters, Limited, I observed in one of the settling tanks which was nearly full of pulverized ore, known metallurgically as 'slime,' that the surface of this material, which was saturated with and covered by a solution of cyanide of potassium, was pitted by holes and marked by trails, which I assumed to belong to some small invertebrate. That they were of organic origin seemed too obvious to be worthy of question.

There was no opportunity for me to wait until the solution was drawn down sufficiently to permit of a careful examination of the surface of the pulverized material, so it remains for some future observer to determine the identity of the form which produced the markings.

The observation is communicated to you in the hope that it may invoke a communication of similar observations on the part of others. What seemed remarkable to the writer was that any form of animal life could exist in a solution of cyanide of potassium.

F. J. H. Merrill.

SPECIAL ARTICLES.

THE PARACHUTE EFFECT OF THISTLE-DOWN.

The importance of the down of the Canada thistle (*Carduus arvensis*) for seed distribution is a matter of common knowledge, but it may not be quite so well known just how this is accomplished from a mechanical point of view.

When the head of the Canada thistle is mature and the day dry (moisture closes up the head even though mature), the scales of the involucre spread and expose the fluffy mass to the air. At this time the achenes may be detached from the receptacle by the slightest force, permitting them to float away attached to the down. This closing of the head is brought about by the unequal turgescence of the cells in the bracts of the involucre.

The down which grows on the receptacle—not on the achenes—serves the function of helping to keep water from entering the head, thus permitting the achenes to become thoroughly dry, though the weather may be damp at the time. Dampness tends to hold the achenes fast to the receptacle, and this tends, in some measure, to defeat the purpose of the down, because it may become detached from the achene and float away without its precious burden. Both the calyx-down and the recep-

tacle-down are of such a nature that water will not adhere to them. This is because the surface has a stronger attraction for air than for water, owing to the fact that the surface is coated with a substance of an oily nature. Alcohol removes this substance.

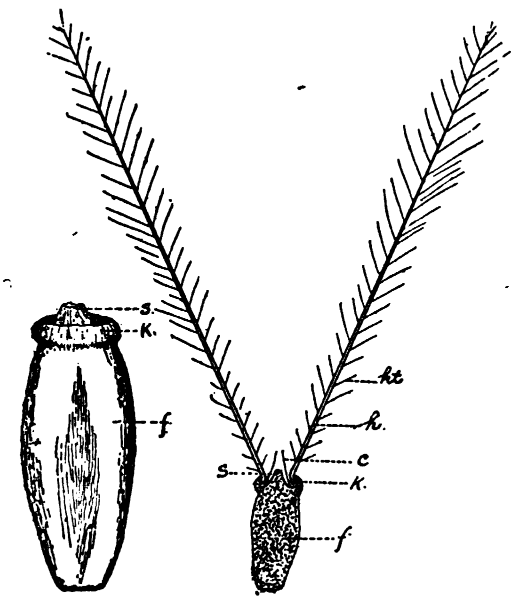

Fig. 1. *f*, the fruit (achene); *k*, collar round the summit of the achene, inside the edge of which the pappus hairs are supported, at the base for a distance of about .25 mm., forming a ring; *h*, the hair; *ht*, the hairlet; *c*, the base of the withered corolla; *s*, remains of the style broken away. (The style and corolla usually persist until the achene breaks from the pappus.) The diagram to the right is an imaginary vertical section. The drawing to the left is a view of an achene after the down has been detached. The hairs when dry are at an angle of about 45° to the vertical. The hairlets are at an angle of about 45° to the axis of the hair. Hence the hairlets make an angle of about 90° to each other, so that at whatever angle they be placed, the resultant effect can not be less than that of 45°. It will be noticed that the collar *k*, being slightly smaller at the extreme edge, clamps round the base of the ring of hairs. This is the more effective because the ring of pappus is slightly larger at its lower edge, making the collar act like a wedge. This is indicated in the diagram to the right.

From the nature and the position of the receptacle-down, it may once have served the function of moving the whole head by the aid of the wind; so that the suggestion is here offered that the achene-down is a later development from the point of view of ĕvolution.

When the down, with its attached achene, is exposed to dry air for a few days, the contracting end of the achene causes it to rupture from the collar of the calyx-down, and thus a separation takes place eventually. This, of course, is an advantage, because the seed may thus reach a suitable place in the soil for germination. If the pappus remained attached, the chances for germination would be greatly diminished, because the down would then be but a hindrance by holding the achene above the soil. In many cases, therefore, the thistle-down seen floating in the air has no achene attached; and this separation would likely take place while floating in the air, because of the favorable conditions there for drying out.

A minute examination was made of several heads of thistle-down with a view to ascertain to what extent the down was adapted to the air conditions. In the heads there are from 95 to 120 achenes; or an average of about 108 per head; and there is an average of 80 hairs to one achene-cluster, and 110 hairlets on each hair. These hairlets are .005 mm. in diameter and 2 mm. long (approximately). The surface area of each hairlet would be $\pi \times .005 \times 2$; and of all the hairlets in each head: $\pi \times .005 \times 2 \times 80 \times 108$ sq. mm. The hairs being each .06 mm. in diameter, and 23 mm. long, the surface area for the whole head would be:

$$\pi \times .06 \times 23 \times 80 \times 108.$$

The cells composing the pappus are filled with air when the achenes are mature, and this adds to the buoyancy, but the inside surface is not here computed because it has nothing to do directly with the surface attraction of the pappus for the air of the atmosphere.

The total external surface area, therefore, would be:

$$\pi \times .005 \times 2 \times 110 \times 80 \times 108 + \pi \times .06 \times 23 \times 80 \times 108$$
$$= 67{,}342.6 \text{ square mm.}$$
$$= 673.426 \text{ square cm.}$$

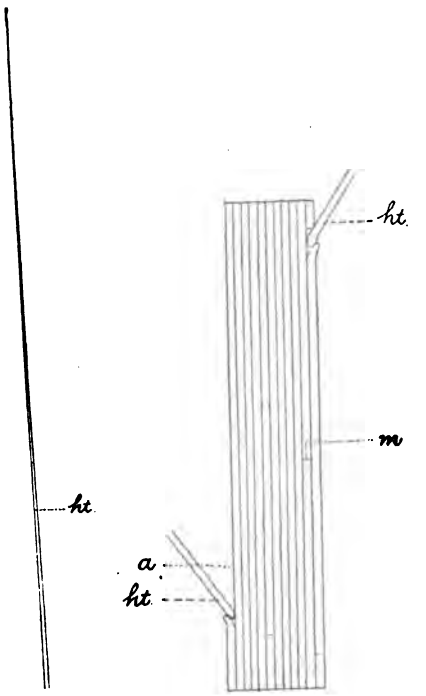

FIG. 2. The diagram to the left shows a hairlet, single cell, cavity filled with air. The other diagram is an optical longitudinal section through the diameter of a hair, showing the long, narrow, thin-walled cells. These are filled with air. *m*, cross wall; *ht*, hairlet; *a*, narrowing due to the extended cell *ht*. This illustrates the chief means of tapering of the hair, it being smaller at this point by the size of the hairlet.

Now, if this down-substance be considered as a flat lamina, it would have an area of one half of 673.426 sq. cm., because the lamina has two sides; and, as the lamina would be so exceedingly thin, the other surfaces may be neglected. Now, if t represent the thickness in centimeters, a the area in sq. cm., and s the specific gravity of cellulose,

then ats = weight in grams,

but, by actual experiment, the weight of all the downs (excluding achenes) in a head is .0561 grams,

$$\text{therefore } ats = .0561$$
$$= \frac{.0561}{as}$$
$$= \frac{.0561}{336\,713 \times 1.13^{1}}$$
$$= .0000375$$

the thickness of the lamina in cm. It would, therefore, require over 26,000 of such laminæ to produce a thickness of one cm.

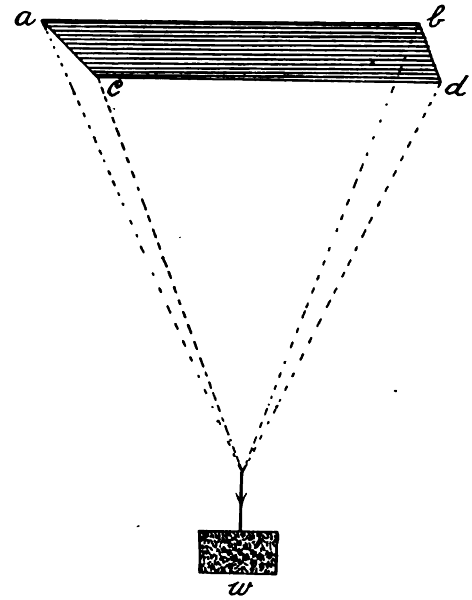

FIG. 3. Illustrates the parachute action of the lamina *abdc* when it is horizontal and, therefore, capable of producing its greatest effort. In the calculation, $w = 150$ lbs.

In the Standard Dictionary there are about 2,300 pages, having a total thickness of 11 cm., something over 200 pages to the centimeter. Therefore, to express in a striking manner, it may be said that it would take about 130 of such laminæ to make the thickness of one leaf of the paper just mentioned.

The weight of the achenes themselves—excluding the down—in a head, are approximately .108 gram; so that, for each gram weight of achenes, there is a surface area of 6,235.42 square centimeters.

[1] The specific gravity of cellulose in Swedish filter paper is 1.13 very approximately.

The adaption of thistle-down to floating in the air is seen at once to be quite remarkable.

The down acts as a parachute to carry the seed, and a calculation will set forth how great this force may be. It will be considered that the lamina referred to is placed horizontally and the achene attached. The rate at which the achene (with the down attached) will fall in still air is as explained in the solution given below:

In the formula $P = .004V^2S$,[2] P stands for the pressure in pounds per square foot, V the velocity in miles per hour, and S the number of square feet.

The downs and the achenes in a head weigh

$$.108 + .0561 = .1641 \text{ gram,}$$

and the surface area of one side of the lamina is 326.713 square centimeters; but one gram $= .0022046$ pound, and one sq. cm. $= .155$ sq. in., therefore,

$$.0022046 \times .1641 = 004\, V^2 \times \frac{326.713 \times 155}{144}$$

$$\therefore\ V = .35 \text{ miles per hr. (approx.)}$$

From this it may be seen that a thistle-down starting from an elevation of 20 feet, would take 20/1848 hours to fall; and if we suppose the wind to be blowing at 20 miles per hour, the achene would be carried a distance of .21 mile, *i. e.*, about one fifth of a mile. In this calculation, all cross currents and changes of air are neglected.

In this parachute calculation, the lamina is supposed to be horizontal. This condition would necessarily give the maximum of the parachute effect. Now, if this be represented by E, the minimum effort could not be less than $1/\sqrt{2}\, E$, because of the configuration of the parts of the thistle-down.

Another illustration might possibly bring out more prominently the parachute effect: If a weight of 150 pounds be attached to the down in such a way that they will act with the maximum effect; and it be required to ascertain how many would be required to 'parachute' that weight so that it would fall at the rate of five miles per hour, the equation would be

$$150 = .004 \times 5 \times 5 \times S,$$

therefore,

$$S = 1{,}500 \text{ square feet;}$$

but the down-lamina is, for a whole head of 108 achenes, 326.713 sq. cm., or .3624 sq. ft., therefore it would require

$$\frac{1{,}500 \times 108}{.36244} = 447{,}019 \text{ downs.}$$

In all these calculations, neither the viscosity of the air nor its capillary (surface) attraction is taken into account, though the latter is very considerable, as may be seen from the fact that small (microscopic) particles of sand, iron and the like, float, and

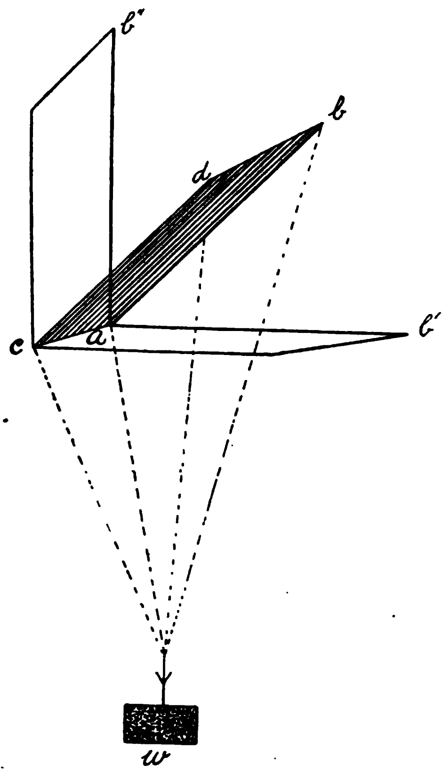

FIG. 4. The plane *abdc* is at an angle of 45°. The horizontal cross-section of the mass of air displaced in the descent of the plane, in this position, would be the area of *abdc* divided by the square root of 2. From the configuration of the parts of the down, this would give the minimum effect. (See Fig. 1.)

[2] Kent's 'Mechanical Engineering,' pocket edition, p. 492. This is the value given by Smeaton, 1759, but others have given it as low as $P = .0029V^2S$.

fall very slowly in the air. Theoretically, a small spherical body should fall at the same rate as a large spherical body of the same composition; but it does not, and this may easily be demonstrated by throwing a shovelful of coal composed of pellets of various sizes—some as fine as dust—into the air at a height of even six or eight feet. The very finest dust floats for some time in the air, and the largest pellets reach the ground first. It is indeed due to this surface attraction that small bodies like pollen grains, fungus spores and the like, are capable of being transported through the air over such great distances.

J. B. Dandeno.
Agricultural College, Michigan,
April 3, 1905.

THE WEIGHT OF THE BRONTOSAURUS.

At the request of Professor H. F. Osborn the writer undertook to make an estimate of the probable weight in the flesh of a *Brontosaurus excelsus*. The mounted skeleton in the American Museum is 66 feet 7 inches long, and from this a very carefully studied model or restoration was made by Mr. Charles R. Knight, who also made use of Dr. W. D. Matthew's studies upon the probable size and arrangement of the muscles in this animal. The skeleton was mounted after the prolonged study and discussion of a number of specialists; its contours are strikingly lifelike, and Mr. Knight's long training well qualified him to infer the external contours of an animal from its internal framework. Hence the model should correspond fairly well with the animal itself.

From the model, a number of plaster casts were made, and one of these was used in the following determination. The model was constructed as nearly as possible to the exact scale of one sixteenth natural size, hence the cubic contents of the model multiplied by the cube of 16 (4096) should indicate the probable volume of water which would be displaced by the animal in the flesh. One of the casts was cut into six pieces of convenient size, which were then made water-tight by a double coating of shellac. Professor William Hallock very kindly consented to determine accurately the cubic contents of these pieces in one of the physical laboratories at Columbia University.

The weight of the cast in air minus its weight in water would equal the weight of an equal volume of water. This differential weight was determined in grams. As a gram is the weight of a cubic centimeter of water the weight of the water displaced gave directly the cubic contents of the model. Professor Hallock found the weight of the water displaced to be 7,595 grams (about .27 cubic feet), or say 7.6 kilograms. Hence the animal itself would displace $7{,}595 \times (16)^3 = 31{,}129{,}$-600 c.c. or 31.13 metric tons. Converting this into tons, we have $31.13 \times 2{,}200 \div 2{,}000 = 32.24$, or say 34½ tons, as the estimated weight of the water displaced by the animal. But as the animal was probably slightly heavier than the water displaced, in order to enable it to walk on the bottom along the shore of lakes and rivers, we may add about ten per cent. to 34½ tons, securing as a final estimate 38 tons.

This result accords very well with Mr. F. A. Lucas's careful estimate of the weight of a 75-foot sulphur bottom whale, an animal of much greater bulk than the *Brontosaurus*. This weighed about 63 tons, and in conversation with the writer Mr. Lucas expressed the opinion that the *Brontosaurus* did not weigh 'much more than half as much.' This opinion seems justified by the estimate given above.

W. K. Gregory.
American Museum of Natural History,
New York,
September 30, 1905.

QUOTATIONS.

COLLEGE ADMINISTRATION.

Of the several conferences of the installation week at Champaign-Urbana, the one announced as a conference of trustees to consider methods of administration builded larger and possibly better than it knew. It included not alone the problems of the conduct of the business machinery of these great corporations, but raised the fundamental issues in regard to *raison d'être* of boards and presidents, and administrative means and measures. And it raised the most pertinent query as to the

dangers inherent in the further development of the presidential office in its present temper. With unexpected corroboration of many men of many minds, the autocracy of the college president—to which President Pritchett has called timely attention—was deplored, not alone as undemocratic in principle and harsh in practise, but as tending to undermine the stability of the academic career, and as taking from it its proper dignity, honor and station. It is certainly notable that an occasion that was convened to glorify the president—though in some part only as the representative of his university—the dominant theme of discussion should take as its text the menace and evils of this office. The inquiry was most amicably and fairly conducted; no disturbing factor of personal criticism intruded itself. It was admitted that the needs of the past—closely associated with pioneering crudities and exacting conditions—demanded dictatorial powers, central responsibility, efficient and compromising direction. Yet it was questioned whether this type of government is at all promising for present and future situations. Our universities have been built up too largely at the sacrifice of the academic career; and with material success and the ambition to be big has come a neglect of quality and of the true ends for which universities are maintained. The faculty has paid all too heavily for the progress which it has, with unacknowledged sacrifice, made possible. The issue is thus nothing less than the rehabilitation of the academic career; the restoration of the faculty to a truly directive authority of the educational affairs of the university; the withdrawal of the president to the more modest office of the leading interpreter of faculty opinion, and the interpretation of the function of the board in a more cooperative, less managerial tone. That intense and hampering sense of accountability—which President Pritchett has likewise emphasized—robs the professorial career of its essential worth; and this accountability directly results from the autocratic government by presidents and boards, that imposes policy upon the faculty, and distributes with both a grudging and an unjust hand rewards for facilitation of administrative measures. Naturally, when stated thus baldly the charge seems exaggerated and in many quarters wholly inappropriate; yet, as a tendency, it has real existence and unusual power to make or mar the academic career. Analogies from the business world have wrought havoc with educational standards, and, unless signs fail, this is to be one of the foremost of educational questions; and it may be that the formal raising of this query will come to be regarded as the memorable feature of the Illinois conferences.—*The Outlook.*

THE BIRD LIFE OF CENTRAL ILLINOIS.

THE Illinois State Laboratory of Natural History is making a qualitative and quantitative survey of the bird life of a typical grain and cattle form of central Illinois, with the intention of continuing and extending statistical studies of this description until average results are arrived at, good for the various crops and regions of the state and for the different seasons of the year. This is taken up mainly as a study in ornithological ecology, but it will nevertheless have an economic value as helping to determine the real significance of birds in relation to agriculture.

The data are obtained by an expert field ornithologist who, with a single companion, crosses a four-hundred-acre farm in various directions and at intervals of about four days, the two observers traveling always fifty yards apart and noting the species and numbers of birds flushed on this strip between them. They carry each time a copy of a plot of that part of the farm covered by their trip, drawn to a scale and showing the distribution and areas of each of the crops. On this plot the position of each bird observed is noted, the series of diagrams thus giving a means of determining the average bird population per acre for each crop as well as for the entire area covered.

This work has been in progress since last June, during which time the birds of something over 1,100 acres have thus been accurately recognized and numbered for three summer months. The average was 2.5 birds per acre, omitting English sparrows, or 3.8

per acre if the sparrows are included. The total number of species observed was 38, and the number of birds identified was 4,257. Fifty-nine per cent. of the individuals seen were bronzed grackles, 13.3 per cent. were English sparrows, 12.5 per cent. were cowbirds, 2.5 per cent. were mourning-doves, and 2.3 per cent. were meadow-larks. Nearly 90 per cent. of all the birds on the farm thus belonged to these five species, and to them was due virtually all the impression which was being made by birds on the plant and insect life of this tract.

THE INTERNATIONAL CONGRESS OF AMERICANISTS.

We have already called attention to the fact that the fifteenth International Congress of Americanists will be held at Quebec from September 10 to 16 of next year. The regulations adopted by the committee of organization are as follows:

Papers will be listed on receipt of title.

Papers will not be assigned a place on the preliminary daily program unless an abstract has been received, as required by the rules and regulations of the congress.

Papers to be read will be arranged according to subject-matter, in a number of divisions corresponding to those of the general program; and papers belonging to the same division will be presented, so far as feasible, on the same day.

Papers in each division will take precedence in the order of the receipt of abstracts.

Authors who intend to submit more than one paper to the congress are requested to designate the paper they desire to read first. The rest of their papers will be placed at the end of the preliminary program of the respective divisions.

In order to insure the prompt publication of the proceedings of the congress, the committee recommends to the congress to set the latest date for the receipt of completed manuscripts and of notes of discussions, October 1, 1906.

SCIENTIFIC NOTES AND NEWS.

Brigadier General A. W. Greely, chief of the U. S. Signal Service, has been elected the first president of the Explorers' Club, an organization recently founded in New York City.

Professor Emil Fischer, of Berlin, has been elected an honorary member of the Society of German Chemists.

Professor Robert Koch, who has been at Amaris in West Usambara and at Uganda to complete his researches on trypanosomes and sleeping sickness, expected to reach Berlin on October 23.

Dr. Forrest Shreve, Bruce fellow in the Johns Hopkins University, sailed for Jamaica on October 13, to spend a year in physiological and ecological work at the Cinchona station of the New York Botanical Garden.

Dr. R. M. Wenley, professor of philosophy in the University of Michigan, has leave of absence for the year, which he is spending in Scotland.

Professor A. B. Stevens, who has been studying in Switzerland for two years, has returned to the University of Michigan and will continue his researches upon the composition of poison ivy.

Miss Fanny Cook Gates, who has been engaged in research work in the Cavendish laboratory since last April, has resumed her duties as head of the physics department in the Woman's College of Baltimore.

Dr. G. R. Holden and Dr. H. M. Little, respectively resident gynecologist and obstetrician of the Johns Hopkins Hospital, have resigned, and Dr. Stephen Rushmore and Dr. F. C. Goldsborough succeed them. Dr. Little will take charge of a department in the hospital connected with McGill University, Canada.

Dr. J. C. R. Laflame, formerly rector of Laval University and president of the Royal Society of Canada, has been appointed by the International Waterways Commission as geological expert to make a report upon the recession of the Canadian side of Niagara Falls.

Baron K. Takaki, of Tokyo, has accepted an invitation to deliver the Cartwright lectures on surgery in Columbia University. Surgeon-General Takaki will sail for America towards the end of December.

AMONG the lectures to be given before the Royal Institution of London during the current session are the following: 'The Origin of the Elephant,' Professor E. Ray Lankester, F.R.S.; 'Submarines,' Sir W. H. White, K.C.B., F.R.S.; 'Geographical Botany interpreted by Direct Response to the Conditions of Life,' Rev. George Henslow; 'The Upper Nile,' Sir Charles Eliot, K.C.M.G.; 'Variation in Man and Woman,' Professor Karl Pearson, F.R.S.; 'Our Atmosphere and its Wonders,' Professor Vivian B. Lewes.

THE Traill-Taylor memorial lecture of the Royal Photographic Society of Great Britain was delivered at the New Gallery, Regent Street, London, on October 24 by Mr. Chapman Jones, F.I.C., F.C.S. The subject was 'Photography, the Servant of Science.'

AT the meeting of the Institution of Civil Engineers on November 7, Sir Alexander R. Binnie, the president, will deliver an inaugural address, and the presentation will take place of the council's awards.

BEFORE the Pupil's Physical Society of Guy's Hospital, on October 12, Dr. William Osler, the regius professor of medicine of Oxford University, delivered an address upon 'Sir Thomas Browne,' who was born on October 19, 1605.

DR. SYLVESTER DWIGHT JUDD, formerly assistant biologist in the U. S. Department of Agriculture and professor of biology in Georgetown University, committed suicide on October 22, two weeks after his discharge from the insane asylum. Dr. Judd, who was thirty-four years of age, graduated from Harvard University in 1894. He had made valuable contributions to economic ornithology.

The annual meeting of the American Physiological Society will be held at the University of Michigan, Ann Arbor, December 27 and 28.

THE twenty-third annual congress of the American Ornithologists' Union will be held at the American Museum of Natural History, New York City, beginning on the evening of Monday, November 13. The evening session will be for the election of officers and members, and for the transaction of routine business. Tuesday and the following days will be for the presentation and discussion of scientific papers, and will be open to the public.

THE tenth International Geological Congress will meet in the City of Mexico at the beginning of September, 1906. Extended excursions have already been arranged to precede and follow the congress.

AT a joint meeting of the Royal Society and the Royal Astronomical Society, held on October 19 at Burlington House, the following reports were presented on the subject of the total eclipse of the sun on August 30: 'Preliminary Account of the Observations made at Sfax, Tunisia,' by Sir William Christie, the astronomer royal; 'Preliminary Report of the Observations made at Guelma, Algeria,' by Mr. H. F. Newall; 'Report of the Eclipse Expedition to Pineda de la Sierra, Spain,' by Mr. J. Evershed; and 'Expedition to Aswan,' by Professor H. H. Turner. A report was also presented by Professor H. L. Callendar, F.R.S.

FRANCE, following the example of England, Germany and other countries, has decided to create an Order of Merit. The new decoration is intended for Frenchmen who shall have distinguished themselves at home or abroad, but whose services would not entitle them to the Legion of Honor. There are to be three grades—chevalier, officer and commander—and the ribbon is to be dark blue. The new order is intended to take the place of the medals and decorations now conferred for special services.

BY the will of the late Benjamin P. Davis, a civil engineer of New York City, $250,000 is bequeathed for public purposes, including $50,000 to the Metropolitan Museum of Art, $50,000 to the Phillips Exeter Academy of New Hampshire and $25,000 to the American Museum of Natural History.

THE Royal College of Surgeons has presented to the medical department of Cambridge University a number of portrait engravings of eminent physicians and surgeons of the seventeenth and eighteenth centuries.

THE valuable collection of succulent plants made during his travels abroad by the late

Rev. H. G. Torre, of Norton Curlieu, Warwickshire, has been presented to the Royal Botanic Society. It comprises some 1,600 specimens of the most ornamental of the class, such as agaves, aloes, echeverias, crassulas and mesembryanthemums. The rockery in the large conservatory has been reconstructed for their accommodation and display.

UNIVERSITY AND EDUCATIONAL NEWS.

THE late George W. Catt, a civil engineer, has bequeathed his engineering books and half the residuary interest in his estate, which in all is estimated at $110,000, to the Iowa State College of Agriculture and Mechanic Arts.

THE trustees of Smith College, at a meeting in Northampton on October 20, voted to use the money donated by Mr. John D. Rockefeller for the erection of an assembly hall and a dormitory. The college register shows the freshman class to be the largest in the history of the college, having 404 members, an increase of 46 over that of last year.

THE statement of the president of the University of Chicago for the quarter ending September 1 contains the following report of receipts and expenditures during the past eight years:

Fiscal Year.	Receipts.	Expenditures.
1897–8	$ 706,973.63	$ 678,399.75
1898–9	723,083.01	719.923 52
1899–0	740,954.93	747,186.62
1900–1	775,654.98	790,583.68
1901–2	977,828.33	944,348.26
1902–3	982.609.94	1,020,224 92
1903–4	939,073.72	1,032,533.39
1904–5	1,003,750.33	1,003,726 47
Total.	$6,849,928.87	$6,936,926.61
Net deficit.	$ 86,997.74	

EMMANUEL COLLEGE, Cambridge, announces that a studentship of the annual value of £150 will be offered for encouragement in research in any branch of study recognized by the university, open to graduates of the university whose age does not exceed 28 on January 1, 1906. It will be tenable in the first instance for one year, but the student may be reelected for a second period of one year, the studentship not to be tenable with a fellowship or any similar studentship.

ACCORDING to the New York *Evening Post* the registration of the University of Pennsylvania is as follows:

	1904–5.	1905–6.
College Department	946	1,089
Wharton School	226	271
Teachers' Course	181	208
Evening School	95	298
Summer School	131	214
Philosophy	213	287
Law	303	315
Veterinary	79	100
Dental	359	322
Medical	546	580
Spring Medical	17	19
Total	3,096	3,703

THE first Servian University was opened on October 15 by the king in presence of the crown prince, the members of the ministry, invited guests and Servian delegates.

MR. ELLSWORTH GAGE LANCASTER has been installed as president of Olivet (Michigan) College.

THE chair of philosophy in Miami University, which was from 1888 to 1905 in charge of Dr. R. B. C. Johnson, now at Princeton, has been filled by the appointment of Elmer E. Powell, Ph.D. (Bonn).

DR. ARTHUR GRAHAM HALL, formerly instructor in mathematics at the University of Michigan and associate professor of mathematics at the University of Illinois, has accepted the professorship of mathematics in Miami University resigned by Edward P. Thompson.

PROFESSOR WALTER M. BOEHM will have charge of the work in physics at Cornell College, Mount Vernon, Ia., during the coming year, Dr. A. Collin having been granted a leave of absence. Mr. Boehm is a graduate of the State University of Iowa, where for three years he served as assistant in physics.

DR. OSCAR VEBLEN, of the University of Chicago, has been appointed preceptor in mathematics in Princeton University.

DR. WILLIAM FOSTER, JR., has been advanced to an assistant professorship of chemistry in Princeton University.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, NOVEMBER 10, 1905.

CONTENTS.

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

IRRIGATION.[1]

SCIENCE has been defined as the medium through which the knowledge of the few can be rendered available to the many; and among the first to avail himself of this knowledge is the engineer. He has created a young science, the offspring, as it were, of the older sciences, for without them engineering could have no existence.

The astronomer, gazing through long ages at the heavens and laying down the courses of the stars, has taught the engineer where to find his place on the earth's surface.

The geologist has taught him where he may find the stones and the minerals which he requires, where he may count on firm rock beneath the soil to build on, where he may be certain he will find none.

The chemist has taught him of the subtle gases and fluids which fill all space, and has shown him how they may be transformed and transfused for his purposes.

The botanist has taught him the properties of all trees and plants, 'from the cedar tree that is in Lebanon even unto the hyssop that springeth out of the wall.'

And all this knowledge would be as nothing to the engineer had he not reaped the fruits of that most severe of all pure and noble sciences—the science of numbers and dimensions, of lines and curves and spaces, of surfaces and solids—the science of mathematics.

Were I to attempt in the course of a single address to touch on all the many

[1] Address of the president to the Engineering Section of the British Association for the Advancement of Science, South Africa, 1905.

branches of engineering, I could do no more than repeat a number of platitudes, which you know at least as well as I do. You would probably have fallen asleep before I was half finished, and it would be the best thing you could do. I think, then, that it will be better to select one branch, a branch on which comparatively little has been written, which has, I understand, a special interest for South Africa, and which has occupied the best years of my life in India, southern Europe, central Asia and Egypt—I mean the science of irrigation. My subject is water—living, life-giving water. It can surely never be a dry subject; but we all know that with the best text to preach on the preacher may be as dry as dust.

IRRIGATION: WHAT IT MEANS.

Irrigation may be defined as the artificial application of water to land for the purposes of agriculture. It is, then, precisely the opposite of drainage, which is the artificial removal of water from lands which have become saturated, to the detriment of agriculture. A drain, like a river, goes on increasing as affluents join it. An irrigation channel goes on diminishing as water is drawn off it. Later on I shall show you how good irrigation should always be accompanied by drainage.

In lands where there is abundant rainfall, and where it falls at the right season of the year for the crop which it is intended to raise, there is evidently no need of irrigation. But it often happens that the soil and the climate are adapted for the cultivation of a more valuable crop than that which is actually raised, because the rain does not fall just when it is wanted, and there we must take to artificial measures.

In other lands there is so little rain that it is practically valueless for agriculture, and there are but two alternatives—irrigation or desert. It is in countries like these that irrigation has its highest triumph; nor are such lands always to be pitied or despised. The rainfall in Cairo is on an average 1.4 inch per annum, yet lands purely agricultural are sold in the neighborhood as high as £150 an acre.

This denotes a fertility perhaps unequaled in the case of any cultivation depending on rain alone, and this in spite of the fact that the Egyptian cultivator is in many respects very backward. The explanation is not far to seek. All rivers in flood carry along much more than water. Some carry alluvial matter. Some carry fine sand. Generally the deposit is a mixture of the two. I have never heard of any river that approached the Nile in the fertilizing nature of the matter borne on its annual floods; with the result that the plains of Egypt have gone on through all ages, with the very minimum of help from foreign manures, yielding magnificent crops and never losing their fertility. Other rivers bring down little but barren sand, and any means of keeping it off the fields should be employed.

PRIMITIVE MEANS OF IRRIGATION.

The earliest and simplest form of irrigation is effected by raising water from a lake, river or well, and pouring it over the land. The water may be raised by any mechanical power, from the brawny arms of the peasant to the newest pattern of pump. The earliest Egyptian sculptures show water being raised by a bucket attached to one end of a long pole, turning on an axis with a heavy counterpoise at the other end. In Egypt this is termed a *shadoof*, and to this day, all along the Nile banks, from morning to night, brown-skinned peasants may be seen watering their fields in precisely this way. Tier above tier they ply their work so as to raise water fifteen or sixteen feet on to their land. By this simple contrivance it

is not possible to keep more than about four acres watered by one *shadoof*, so you may imagine what an army is required to irrigate a large surface. Another method, largely used by the natives of northern India, is the shallow bucket suspended between two strings, held by men who thus bale up the water. A step higher is the water-wheel, with buckets or pots on an endless chain around it, worked by one or a pair of bullocks. This is a very ordinary method of raising the water throughout the East, where the water-wheel is of the rudest wooden construction and the pots are of rough earthenware. Yet another method of water-raising is very common in India from wells where the spring level may be as deep as one hundred feet or more. A large leathern bag is let down the well by a rope passing over a pulley and raised by a pair of bullocks, which haul the bag up as they run down a slope the depth of the well. An industrious farmer with a good well and three pairs of good bullocks can keep as much as twelve acres irrigated in northern India, although the average is much less there. The average cost of a masonry well in India varies from £20 to £40, according to the depth required. But it is obvious that in many places the geological features of the country are such that well-sinking is impracticable. The most favorable conditions are found in the broad alluvial plains of a deltaic river, the subsoil of which may be counted on as containing a constant supply of water.

PUMPS AND WINDMILLS.

All these are the primitive water-raising contrivances of the East. Egypt has of late been more in touch with Western civilization, and since its cotton and sugar-cane crops yield from £6 to £8, or even £10 per acre, the well-to-do farmer can easily afford a centrifugal pump worked by steam power. Of these there are now many hundreds fixed or portable working on the Nile banks in Egypt. Where wind can be counted on the windmill is a very useful and cheap means of raising water. But everything depends on the force and the reliability of the wind. In the dry western states of America wind power is largely used for pumping. It is found that this power is of little use if its velocity is not at least six miles per hour. (The mean force of the wind throughout the whole United States is eight miles per hour.) Every windmill, moreover, should discharge its water into a tank. It is evident that irrigation can not go on without cessation day and night, and it may be that the mill is pumping its best just when irrigation is least wanted. The water should, therefore, be stored till required. In America it is found that pumping by wind power is about two-thirds of the cost of steam power. With a reservoir five to fifteen acres may be kept irrigated by a windmill. Without a reservoir three acres is as much as should be counted on. Windmills attached to wells from 30 to 150 feet deep cost from £30 to £70.

ARTESIAN WELLS.

Up to now the artesian well can not be counted on as of great value for irrigation. In the state of California there are said to be 8,097 artesian wells, of a mean depth of 210 feet, discharge .12 cubic feet per second, and original cost on an average £50. Thirteen acres per well is a large outturn.

In Algeria the French have bored more than 800 artesian wells, with a mean depth of 142 feet, and they are said to irrigate 50,000 acres. But this is scattered over a large area. Otherwise, the gathering ground would probably yield a much smaller supply to each well than it now has. In Queensland artesian wells are largely used for the water supply of cattle stations, but not for irrigation.

WELL IRRIGATION.

It is evident that where water has to be raised on to the field there is an outlay of human or mechanical power which may be saved if it can be brought to flow over the fields by gravitation. But there is one practical advantage in irrigating with the water raised from one's own well or from a river. It is in the farmer's own hands. He can work his pump and flood his lands when he thinks best. He is independent of his neighbors, and can have no disputes with them as to when he may be able to get water and when it may be denied to him. In Eastern countries, where corruption is rife among the lower subordinates of government, the farmer who sticks to his well knows that he will not require to bribe any one; and so it is that in India about thirteen millions of acres, or 30 per cent. of the whole annual irrigation, is effected by wells. Government may see fit to make advances to enable the farmer to find his water and to purchase the machinery for raising it; or joint-stock companies may be formed with the same object. Beyond this all is in the hands of the landowner himself.

CANAL IRRIGATION.

Irrigation on a large scale is best effected by diverting water from a river or lake into an artificial channel, and thence on to the fields. If the water surface of a river has a slope of two feet per mile, and a canal be drawn from it with a surface slope of one foot per mile, it is evident that at the end of a mile the water in the canal will be one foot higher than that in the river; and if the water in the river is ten feet below the plain, at the end of ten miles the water in the canal will be flush with the plain, and henceforth irrigation can be effected by simple gravitation.

When there is no question of fertilizing deposit, and only pure water is to be had, the most favorable condition of irrigation is where the canal or the river has its source of supply in a great lake. For, be the rainfall ever so heavy, the water surface in the lake will not rise very much, nor will it greatly sink at the end of a long drought. Where there is no moderating lake, a river fed from a glacier has a precious source of supply. The hotter the weather, the more rapidly will the ice melt, and this is just when irrigation is most wanted.

Elsewhere, if crops are to be raised and the rain can not be counted on, nor well irrigation be practised, water storage becomes necessary, and it is with the help of water storage that in most countries irrigation is carried on.

WATER STORAGE.

To one who has not given the subject attention surprise is often expressed at the large volume of water that has to be stored to water an acre of land. In the case of rice irrigation in India, it is found that the storage of a million cubic feet does not suffice for more than from six to eight acres. For the irrigation of wheat about one third this quantity is enough. It would never pay to excavate on a level plain a hollow large enough to hold a million cubic feet of water. It is invariably done by throwing a dam across the bed of a river or a valley and ponding up the water behind it. Many points have here to be considered: The length of dam necessary, its height, the material of which it is to be constructed, the area and the value of the land that must be submerged, the area of the land that may be watered. The limits of the height of a dam are from about 150 to 15 feet. If the slope of the valley is great it may be that the volume which can be ponded up with a dam of even 150 feet is inconsiderable, and the cost may be prohibitory. On the other hand, if the country is very flat, it may be that a dam of only 20 feet high may require to be of quite an inor-

dinate length, and compensation for the area of land to be submerged may become a very large item in the estimate. I have known of districts so flat that in order to irrigate an acre more than an acre must be drowned. This looks ridiculous, but is not really so, for the yield of an irrigated acre may be eight or ten times that of an unirrigated one; and after the storage reservoir has been emptied it is often possible to raise a good crop on the saturated bed.

The advantage of a deep reservoir is, however, very great, for the evaporation is in proportion to the area of the surface, and if two reservoirs contain the same volume of water, and the depth of one is double that of the other, the loss by evaporation from the shallow one will be double that of the deep one. In India, from time immemorial, it has been the practise to store water for irrigation, and there are many thousands of reservoirs, from the great artificial lakes holding as much as 5,000 or 6,000 millions of cubic feet, down to the humble village tank holding not a million. There are few of which the dam exceeds 80 feet in height, and such are nearly always built of masonry or concrete. For these it is absolutely necessary to have sound rock foundations. If the dam is to be of earth, the quality of the soil must be carefully seen to, and there should be a central core of puddle resting on rock and rising to the maximum height of water surface. If the dam is of masonry, there may perhaps be no harm done should the water spill over the top. If it is of earth, this must never happen, and a waste weir must be provided, if possible cut out of rock or built of the best masonry, and large enough to discharge the greatest possible flood. More accidents occur to reservoirs through the want of sufficient waste weirs or their faulty construction than from any other cause.

As important as the waste weir are the outlet sluices through which the water is conveyed for the irrigation of the fields. If possible they should be arranged to serve at the same time as scouring sluices to carry off the deposit that accumulates at the bottom of the reservoir. For, unless provided with very powerful scouring sluices, sooner or later the bed of the reservoir will become silted up, and the space available for water storage will keep diminishing. As this happens in India, it is usual to go on raising the embankment (for it does not pay to dig out the deposit), and so the life of a reservoir may be prolonged for many years. Ultimately it is abandoned, as it is cheaper to make a new reservoir altogether than to dig out the old one.

ITALIAN IRRIGATION.

For the study of high-class irrigation there is probably no school so good as is to be found in the plains of Piedmont and Lombardy. Every variety of condition is to be found here. The engineering works are of a very high class, and from long generations of experience the farmer knows how best to use his water.

The great river Po has its rise in the foothills to the west of Piedmont. It is not fed from glaciers, but by rain and snow. It carries with it a considerable fertilizing matter. Its temperature is higher than that of glacial water—a point to which much importance is attached for the very valuable meadow irrigation of winter. From the left bank of the Po, a few miles below Turin, the great Cavour Canal takes its rise, cutting right across the whole drainage of the country. It has a full-supply discharge of 3,800 cubic feet per second; but it is only from October to May that it carries anything like this volume. In summer the discharge does not exceed 2,200 cubic feet per second, which would greatly cripple the value of the work were

it not that the glaciers of the Alps are melting then, and the great torrents of the Dora Baltea and Sesia can be counted on for a volume exceeding 6,000 cubic feet per second.

Lombardy is in no respect worse off than Piedmont for the means of irrigation; and its canals have the advantage of being drawn from the lakes Maggiore and Como, exercising a moderating influence on the Ticino and Adda Rivers, which is sadly wanted on the Dora Baltea. The Naviglio Grande of Lombardy is drawn from the left bank of the Ticino, and is used largely for navigation, as well as irrigation. It discharges between 3,000 and 4,000 cubic feet per second, and nowhere is irrigation probably carried on with less expense. From between Lake Maggiore and the head of the Naviglio Grande a great new canal, the Villoresi, has been constructed during the last few years with head sluices capable of admitting 6,700 cubic feet per second, of which, however, 4,200 cubic feet have to be passed on to the Naviglio Grande. Like the Cavour Canal, the Villoresi crosses all the drainage coming down from the foothills to the north. This must have entailed the construction of very costly works.

IRRIGATION IN NORTHERN INDIA.

It is in India that irrigation on the largest scale is to be found. The great plains of northern India are peculiarly well adapted for irrigation, which is a matter of life and death to a teeming population all too well accustomed to a failure of the rain supply.

The Ganges, the Jumna and the great rivers of the Punjab have all been largely utilized for feeding irrigation canals. The greatest of these, derived from the river Chenab, and discharging from 10,500 to 3,000 cubic feet per second, was begun in 1889, with the view of carrying water into a tract entirely desert and unpopulated. It was opened on a small scale in 1892, was then enlarged, and ten years after it irrigated in one year 1,829,000 acres, supporting a population of 800,000 inhabitants, colonists from more congested parts of India.

The Ganges Canal, opened in 1854, at a time when there was not a mile of railway, and hardly a steam engine within a thousand miles, has a length of about 9,900 miles, including distributing channels. It was supplemented in 1878 by a lower canal, drawn from the same river 130 miles further down, and these two canals now irrigate between them 1,700,000 acres annually. On all these canals are engineering works of a very high class. The original Ganges Canal, with a width of bed of 200 feet, a depth of ten feet, and a maximum discharge of 10,000 cubic feet per second, had to cross four great torrents before it could attain to the watershed of the country, after which it could begin to irrigate. Two of these torrents are passed over the canal by broad super-passages. Over one of them the canal is carried in a majestic aqueduct of fifteen arches, each of fifty feet span; and the fourth torrent, the most difficult of all to deal with, crosses the canal at the same level, a row of forty-seven floodgates, each ten feet wide, allowing the torrent to pass through and out of the canal.

Elsewhere there are rivers in India, rising in districts subject to certain heavy periodical rainfall, and carrying their waters on to distant plains of very uncertain rainfall. At a small expense channels can sometimes be constructed drawing off from the flooded river water sufficient thoroughly to saturate the soil, and render it fit to be ploughed up and sown with wheat or barley, which do not require frequent watering. The canal soon dries up, and the sown crop must take its chance; but a timely shower of rain may come in to help it, or well irrigation

may mature the crop. These, which are known in India as inundation canals, are of high value.

SOUTHERN INDIA.

In southern India there are three great rivers, drawing their supply from the line of hills called the Ghats, running parallel to and near the western coast, and after a long course discharging into the Bay of Bengal on the east coast. Against the Ghats beats the whole fury of the tropical southwest monsoon, and these rivers for a few months are in high flood. As they approach the sea they spread out in the usual deltaic form. Dams have been built across the apex of these deltas, from which canals have been drawn, and the flood waters are easily diverted over the fields, raising a rice crop of untold value in a land where drought and famine are too common. But for the other months of the year these rivers contain very little water, and there is now a proposition for supplementing them with very large reservoirs.

A very bold and successful piece of irrigation engineering was carried out a few years ago in south India, which deserves notice. A river named the Periyar took its rise in the Ghats, and descended to the sea on the west coast, where there was no means of utilizing the water, and a good deal of money had periodically to be spent in controlling its furious floods. A dam has now been built across its course, and a tunnel has been made through the mountains, enabling the reservoir to be discharged into a system of canals to the east, where there is a vast plain much in need of water.

In the native state of Mysore, in southern India, there are on the register about 40,000 irrigation reservoirs (or tanks, as they are called), or about three to every four square miles, and the nature of the country is such that hundreds may be found in the basin of one river—small tanks in the upper branches and larger ones in the lower, as the valley widens out, and these require constant watchful attention. From time to time tropical rainstorms sweep over the country. If then even a small tank has been neglected, and rats and porcupines have been allowed to burrow in the dam, the flood may burst through it, and sweep on and over the dam of the next village, lower down. One dam may then burst after another, like a pack of cards, and terrible loss occurs.

In this state of Mysore a very remarkable irrigation reservoir is now under construction at a place called Mari·Kanave. Nature seems here to have formed an ideal site for a reservoir, so that it is almost irresistible for the engineer to do his part, even although irrigation is not so badly wanted here as elsewhere. The comparatively narrow neck of a valley containing 2,075 square miles is being closed by a masonry dam 142 feet high. The reservoir thus formed will contain 30,000 million cubic feet of water, but it is not considered that it will fill more than once in thirty years. Nor is there irrigable land requiring so great a volume of water. Much less would be sufficient, so such a high dam is not needed; but the construction of a waste weir to prevent the submergence of a lower dam would require such heavy excavation through one of the limiting hills that it is cheaper to raise the dam and utilize a natural hollow in the hillside for a waste weir.

IRRIGATION IN EGYPT.

No lecture on irrigation would be complete without describing what has been done in Egypt. You are generally familiar with the shape of that famous little country. Egypt proper extends northwards from a point in the Nile about 780 miles above Cairo—a long valley, never eight miles wide, sometimes not a half a mile.

East and west of this lies a country broken into hills and valleys, wild crags, level stretches, but everywhere absolutely sterile, dry sand and rock, at such a level that the Nile flood has never reached it to cover its nakedness with fertile deposit. A few miles north of Cairo the river bifurcates, and its two branches flow each for about 130 miles to the sea. As you are probably aware, with rivers in a deltaic state the tendency is for the slope of the country to be away from the river, and not towards it. In the Nile Valley the river banks are higher than the more distant lands. From an early period embankments were formed along each side of the river, high enough not to be topped by the highest flood. At right angles to these river embankments others were constructed, dividing the whole valley into a series of oblongs, surrounded on three sides by embankments, on the fourth by the desert heights. These oblong areas vary from about 50,000 to 3,000 acres. I have said the slope of the valley is away from the river. It is easy, then, when the Nile is low, to cut short deep canals in the river banks, which fill as the river rises and carry the precious mud-charged water into these great flats. There the water remains for a month or more, some three or four feet deep, depositing its mud, and then at the end of the flood it may either be run off direct into the receding river, or cuts may be made in the cross embankments and the water passed off one flat after another, and finally rejoin the river. This takes place in November, when the river is rapidly falling. Whenever the flats are firm enough to allow a man to walk over them with a pair of bullocks, the mud is roughly turned over with a wooden plough, or even the branch of a tree, and wheat or barley is immediately sown. So soaked is the soil after the flood that the seed germinates, sprouts and ripens in April without a drop of rain or any more irrigation, except what, perhaps, the owner may give from a shallow well dug in the field. In this manner was Egypt irrigated up to about a century ago. The high river banks which the flood could not cover were irrigated directly from the river, the water being raised as I have already described.

THE BARRAGE.

With the last century, however, appeared a very striking figure in Egyptian history, Muhammed Ali Pasha, who came from Turkey a plain captain of infantry, and before many years had made himself master of the country, yielding only a very nominal respect to his suzerain lord, the Sultan, at Constantinople.

Muhammed Ali soon recognized that with this flood system of irrigation only one cereal crop was raised in the year, while with such a climate and such a soil, with a teeming population and with the markets of Europe so near, something far more valuable might be raised. Cotton and sugar-cane would fetch far higher prices; but they could only be grown at a season when the Nile is low, and they must be watered at all seasons. The water-surface at low Nile is about twenty-five feet below the flood-surface, or more than twenty feet below the level of the country A canal, then, running twelve feet deep in the flood would have its bed thirteen feet above the low-water surface. Muhammed Ali ordered the canals in lower Egypt to be deepened; but this was an enormous labor, and as they were badly laid out and graded they became full of mud during the flood and required to be dug out afresh. Muhammed Ali was then advised to raise the water-surface by erecting a dam (or, as the French called it, a *barrage*) across the apex of the delta, twelve miles north of Cairo, and the result was a very costly and imposing work, which it took long years and untold wealth to construct, and which

was no sooner finished than it was condemned as useless.

EGYPTIAN IRRIGATION SINCE THE ENGLISH OCCUPATION.

With the English occupation in 1883 came some English engineers from India, who, supported by the strong arm of Lord Cromer, soon changed the situation. The first object of their attention was the *barrage* at the head of the delta, which was made thoroughly sound in six years and capable of holding up fifteen feet of water. Three great canals were taken from above it, from which a network of branches are taken, irrigating the province to the left of the western, or Rosetta branch of the river, the two provinces between the branches, and the two to the right of the eastern, or Damietta branch.

In upper Egypt, with one very important exception (the Ibrahimieh Canal, which is a perennial one), the early flood system of irrigation, yielding one crop a year, prevailed until very recently, but it was immensely improved after the British occupation by the addition of a great number of masonry head sluices, aqueducts, escape weirs, etc., on which some £800,000 was spent. With the completion of these works, and of a complete system of drainage, to be alluded to further on, it may be considered that the irrigation system of Egypt was put on a very satisfactory basis. There was not much more left to do, unless the volume of water at disposal could be increased.

Probably no large river in the world is so regular as the Nile in its periods of low supply and of flood. It rises steadily in June, July and August. Then it begins to go down, at first rapidly, then slowly, till the following June. It is never a month before its time, never a month behind. It is subject to no exceptional floods from June to June. Where it enters Egypt the difference between maximum and minimum Nile is about twenty-five feet. If it rises three and one half feet higher the country is in danger of serious flooding. If its rise is six feet short of the average there existed in former days a great risk that the floods would never cover the great flats of upper Egypt, and thus the ground would remain as hard as stone, and sowing in November would be impossible. Fortunately the good work of the last twenty years very much diminishes this danger.

THE ASSUAN DAM AND RESERVOIR.

In average years the volume of water flowing past Cairo in September is from thirty-five to forty times the volume in June. Far the greater part of this flood flows out to the sea useless. How to catch and store this supply for use the following May and June was a problem early pressed on the English engineers in Egypt.

During the time of the highest flood the Nile carries along with it an immense amount of alluvial matter, and when it was first proposed to store the flood-water the danger seemed to be that the reservoir would in a few years be filled with deposit, as those I have described in India. Fortunately it was found that after November the water was fairly clear, and that if a commencement were made even as late as that there would still be water enough capable of being stored to do enormous benefit to the irrigation.

A site for a great dam was discovered at Assuan, 600 miles south of Cairo, where a dyke of granite rock crosses the valley of the river, occasioning what is known as the First Cataract. On this ridge of granite a stupendous work has now been created. A great wall of granite 6,400 feet long has been thrown across the valley, 23 feet thick at the crest, 82 feet at the base. Its height above the rock-bed of the river is 130 feet. This great wall or dam holds up a depth

of 66 feet of water, which forms a lake of more than 100 miles in length up the Nile Valley, containing 38,000 million cubic feet of water.

The dam is pierced with 180 sluices, or openings, through which the whole Nile flood, about 360,000 cubic feet per second, is discharged. A flight of four locks, each 260 by 30 feet, allows of free navigation past the dam. The foundation-stone of this great work was laid in February 1899, and it was completed in less than four years. At the same time a very important dam of the pattern of the barrage north of Cairo was built across the Nile at Assiut, just below the head of the Ibrahimieh Canal, not with the object of storing water, but to enable a requisite supply at all times to be sent down that canal.

The chief use of the great Assuan reservoir is to enable perennial irrigation, such as exists in lower Egypt, to be substituted in upper Egypt for the basin system of watering the land only through the Nile flood; that is, to enable two crops to be grown instead of one every year, and to enable cotton and sugar-cane to take the place of wheat and barley. But a great deal more had to be done in order to obtain the full beneficial result of the work. About 450,000 acres of basin irrigation are now being adapted for perennial irrigation. Many new canals have had to be dug, others to be deepened. Many new masonry works have had to be built. It is probable the works will be finished in 1908. There will then have been spent on the great dam at Assuan, the minor one at Assiut, and the new canals of distribution in upper Egypt about six and a half millions sterling. For this sum the increase of land rental will be about £2,637,000, and its sale value will be increased by about £26,570,000.

DRAINAGE.

In the great irrigation systems which I have been describing for a long time little or no attention was paid to drainage. It was taken for granted that the water would be absorbed, or evaporated, and get away somehow without doing any harm. This may hold good for high-lying lands, but alongside of these are low-lying lands, into which the irrigation water from above will percolate and produce waterlogging and marsh. Along with the irrigation channel should be constructed the drainage channel, and Sir W. Willcocks, than whom there is no better authority on this subject, recommends that the capacity of the drain should be one third that of the canal. The two should be kept carefully apart—the canal following the ridges, the drain following the hollows of the country, and one in no case obstructing the other. This subject of drainage early occupied the attention of the English engineers in Egypt. In the last twenty years many hundred miles of drains have been excavated, some as large as 50 feet width of bed and 10 feet deep.

IRRIGATION IN AMERICA.

If it is to Italy that we should look for highly finished irrigation works and careful water distribution, and to India and Egypt for widespreading tracts of watered land, it is to America that we naturally look for rapid progress and bold engineering. In the western states of America there is a rainfall of less than 20 inches per annum, the consequence of which is a very rapid development of irrigation works. In 1889 the irrigation of these western states amounted to 3,564,416 acres. In 1900 it amounted to 7,539,545 acres. Now it is at least 10,000,000 acres. The land in these states sells from 10s. to £1 per acre if unirrigated. With irrigation the same land fetches £8 10s. per acre. The works are often rude and of a temporary nature, the extensive use of timber striking a foreigner from the old world. Some of the

American canals are on a large scale. The Idaho Company's canal discharges 2,585 cubic feet, the Turlook Canal in California 1,500 cubic feet, and the North Colorado Canal 2,400 cubic feet per second. These canals have all been constructed by corporations or societies, in no case by government. On an average it has cost about 32s. per acre to bring the water on to the land, and a water-rate is charged of from £2 8s. to £4 per acre, the farmer paying in addition a rate of from 2s. to 10s. per acre annually for maintenance. Distributary channels of less than five feet wide cost less than £100, up to ten feet wide about £150 per mile.

THE INTRODUCTION OF IRRIGATION INTO A COUNTRY.

It is evident that there are many serious considerations to be taken into account before entering on any large project for irrigation. Statistics must be carefully collected of rainfall, of the sources of water supply available, and of the amount of that rainfall which it is possible to store and utilize. The water should be analyzed if there is any danger of its being brackish. Its temperature should be ascertained. It should be considered what will be the effect of pouring water on the soil, for it is not always an unmixed benefit. A dry climate may be changed into a moist, and fever and ague may follow. In India there are large tracts of heavy black soil, which with the ordinary rainfall produce excellent crops nine years out of ten, and where irrigation would rather do harm than good. But in the tenth year the rains fail, and without artificial irrigation the soil will yield nothing. So terrible may be the misery caused by that tenth year of drought that even then it might pay a government to enter on a scheme of irrigation. But it is evident that it might not pay a joint-stock company.

In all cases it is of the first importance to establish by law the principle that all rivers or streams above a certain size are national property, to be utilized for the good of the nation. Even where there is no immediate intention of constructing irrigation works it is well to establish this principle. Otherwise vested rights may be allowed to spring up, which it may be necessary in after years to buy out at a heavy cost.

MODES OF DISTRIBUTING AND ASSESSING WATER.

Where the river is too inconsiderable to be proclaimed as national property, and where there is no question of spreading the water broadcast over the land, but of bestowing it with minute accuracy over small areas to rear valuable plants, such as fruit-trees, it may be very well left to local societies or to syndicates of farmers to manage their own affairs. Where irrigation is on a larger scale, and its administration is a matter of national importance, the control of the water requires the closest consideration, especially if, as is usually the case, the area which may be irrigated exceeds the volume of water available to irrigate it, and where the water is delivered to the fields by gravitation without the labor of raising it. It must be decided on what principle the farmer's right to the water is to be determined. Is he to obtain water in proportion to the area of his land which is irrigable? If part of the irrigable land is not yet cultivated, is some of the supply to be reserved for such land? Is he to pay in proportion to the area actually watered for each crop, or to the area which he might water if he chose? Where the slope of the land is sufficient to allow the water to flow freely out of a sluice into the field channel, it is not difficult to measure the water discharged. Modules have been invented for this purpose, and the owner of the field may

be required to pay for so many cubic feet of water delivered. The government or the association owning the canal will then have nothing to do with the way in which the water is employed, and self-interest will force the farmer to exercise economy in flooding his land. But even then precautions must be taken to prevent him from keeping his sluice open when it should be shut.

In Italy and in America water is generally charged by the module; but in many cases, where the country is very flat, the water can not fall with a free drop out of the sluice, and, as far as I know, no satisfactory module has yet been invented for delivering a constant discharge through a sluice when the head of water in the channel of supply is subject to variation. These are the conditions prevailing in the plains of northern India, where there is a yearly area of canal irrigation of about six millions of acres. The cultivator pays not in proportion to the volume of water he uses, but on the area he waters every crop, the rate being higher or lower according as the nature of the crop demands more or less water.

The procedure of charging for water is, then, as follows: When the crop is nearly ripe the canal watchman, with the village accountant and the farmers interested, go over the fields with a government official. The watchman points out a field which he says has been watered. The accountant, who has a map and field-book of the village, states the number and the area of the field and its cultivator. These are recorded along with the nature of the crop watered. If the cultivator denies that he has received water, evidence is heard and the case is settled. A bill is then made out for each cultivator, and the amount is recovered with the taxes.

This system is perfectly understood, and works fairly well in practise. But it is not a satisfactory one. It holds out no inducement to the cultivator to economize water, and it leaves the door open to a great deal of corruption among the canal watchmen and the subordinate revenue officials.

GOVERNMENT CONTROL OF WATER SUPPLY.

Where the subject agricultural population is unfitted for representative government it is best that the government should construct and manage the irrigation, on rules carefully considered and rigorously enforced, through the agency of officers absolutely above suspicion of corruption or unfair dealing. Such is the condition in Egypt and in the British possessions in India. Objections to it are evident enough. Officials are apt to be formal and inelastic, and they are often far removed from any close touch with the cultivating classes. But they are impartial and just, and I know of no other system that has not still greater defects.

Even if the agricultural classes in India were much better educated than they are, it would still be best that the control of the irrigation should rest with the government. By common consent it is the government alone that rules the army. Now the irrigation works form a great army, of which the first duty is to fight the grim demon of famine. Their control ought, therefore, to rest with the government; but the conditions are very different when the agricultural classes are well educated and well fitted to manage their own affairs.

Irrigation is too new and experimental in America for us to look there for a well-devised scheme of water control. The laws and rules on the subject vary in different states, and are often contradictory. It is better to look at the system evolved after long years in north Italy.

THE ITALIAN SYSTEM.

I have already alluded to the great

Cavour Canal in Piedmont. This fine work was constructed by a syndicate of English and French capitalists, to whom the government gave a concession in 1862. Circumstances to which I need not allude ruined this company, and the government, who already had acquired possession of many other irrigation works in Piedmont, took over the whole Cavour Canal in 1874, a property valued at above four millions sterling, and ever since the government has administered it.

The chief interest of this administration centers on the Irrigation Association west of the Sesia,[2] an association that owes its existence to the great Count Cavour. It takes over from the government the control of all the irrigation effected by the Cavour and other minor canals within a great triangle lying between the left bank of the Po and the right bank of the Sesia. The association purchases from the government from 1,250 to 1,300 cubic feet per second. In addition to this it has the control of all the water belonging to private canals and private rights, which it purchases at a fixed rate. Altogether it distributes about 2,275 cubic feet per second, and irrigates therewith about 141,000 acres, of which rice is the most important crop. The association has 14,000 members, and controls 9,600 miles of distributary channels. In each parish is a council, or, as it is called, a *consorzio,* composed of all landowners who take water. Each *consorzio* elects one or two deputies, who form a sort of water parliament. The deputies are elected for three years, and receive no salary. The assembly of deputies elects three committees—the direction-general, the committee of surveillance, and the council of arbitration. The first of these committees has to direct the whole distribution of the waters, to see to the conduct of the employees, etc. The committee of surveillance has to see that the direction-general does its duty. The council of arbitration, which consists of three members, has most important duties. To it may be referred every question connected with water-rates, all disputes between members of the association or between the association and its servants, all cases of breaches of rule or of discipline. It may punish by fines any member of the association found at fault, and the sentences it imposes are recognized as obligatory, and the offender's property may be sold up to carry them into effect. An appeal may be made within fifteen days from the decisions of this council of arbitration to the ordinary law courts, but so popular is the council that, as a matter of fact, such appeals are never made.

[2] See Mr. Elwood Mead's 'Report on Irrigation in Northern Italy,' printed for the Department of Agriculture, Washington, 1904.

To effect the distribution of the water the area irrigated is divided into districts, in each of which there is an overseer in charge and a staff of guards to see to the opening and closing of the modules which deliver the water into the minor watercourses. In November of each year each parish sends in to the direction-general an indent of the number of acres of each description of crop proposed to be watered in the following year. If the water is available the direction-general allots to each parish the number of modules necessary for this irrigation; but it may quite well happen that the parish may demand more than can be supplied, and may have to substitute a crop like wheat, requiring little water, for rice, which requires a great deal.

The government executes and pays for all repairs on the main canals. It further executes, at the cost of the Irrigation Association, all repairs on the minor canals. The association, then, has no engineers in its employ, but a large staff of irrigators.

The irrigation module employed in Piedmont is supposed to deliver 2.047 cubic feet per second. The association west of the Sesia buys from the government what water it requires at a rate fixed at 800 liras per module, or £15 12s. 7d. per cubic foot per second per annum.

The association distributes the water by module to each district, and the district by module to each parish. Inside the parish each farmer pays, according to the area he waters, a sum to cover all the cost of the maintenance of the irrigation system, and his share of the sum which the association has to pay to the government. This sum varies from year to year according as the working expenses of the year increase or diminish.

I have already mentioned the recently constructed Villoresi Canal in Lombardy. This canal belongs to a company, to whom the government have given large concessions. This company sells its water wholesale to four districts, each having its own secondary canal, the cubic meter per second, or 35.31 cubic feet per second, being the unit employed. These districts, again, retail the water to groups of farmers termed *comizios*, whose lands are watered by the same distributary channels, their unit being the liter, or .035 cubic foot per second. Within the *comizio* the farmer pays according to the number of hours per week that he has had the full discharge of the module.

I have thought it worth while to describe at some length the systems employed on these Italian canals, for the Italian farmers set a very high example, in the loyal way in which they submit to regulations which there must at times be a great temptation to break. A sluice surreptitiously opened during a dark night, and allowed to run for six hours, may quite possibly double the value of the crop which it waters. It is not an easy matter to distribute water fairly and justly between a number of farms at different levels, dependent on different watercourses, cultivating different crops. But in Piedmont this is done with such success that an appeal from the council of arbitration to the ordinary law courts is unheard of. It is thought apparently as discreditable to appropriate an unfair supply of water as to steal a neighbor's horse, as discreditable to tamper with the lock of the water module as with the lock of a neighbor's barn.

MR. SCHUYLER'S VIEWS AS TO GOVERNMENT CONTROL.

Where such a high spirit of honor prevails I do not see why syndicates of farmers should not construct and maintain a good system of irrigation. Nevertheless, I believe it is better that government should take the initiative in laying out and constructing the canals and secondary channels at least. A recent American author, Mr. James Dix Schuyler, has put on record: "That storage reservoirs are a necessary and indispensable adjunct to irrigation development, as well as to the utilization of power, requires no argument to prove. That they will become more and more necessary to our western civilization is equally sure and certain; but the signs of the times seem to point to the inevitable necessity of governmental control in their construction, ownership and administration."

This opinion should not be disregarded. Sir W. Willcocks has truly remarked: "If private enterprise can not succeed in irrigation works of magnitude in America, it will surely not succeed in any other country in this world." What its chances may be in South Africa I leave to my hearers to say. It is not a subject on which a stranger can form an opinion.

C. Scott Moncrieff.

THE AMERICAN ANTHROPOLOGICAL ASSOCIATION.

A SPECIAL meeting of the American Anthropological Association was held in the Department of Anthropology at the Affiliated Colleges of the University of California, San Francisco, August 29–31, 1905.

This, the first meeting of the association ever held west of St. Louis, was presided over by Professor Frederick W. Putnam, Dr. A. L. Kroeber being secretary of the committee on program and arrangements. Dr. Charles Peabody was elected secretary *pro tempore,* in place of Dr. George Grant MacCurdy, the secretary, whose enforced absence was due to injuries sustained in a bicycle accident.

The second day's sessions were held at the California Academy of Sciences; and those of the third day, at the University of California, Berkeley, in conjunction with the California Branch of the American Folk-Lore Society.

COMMITTEES.

Two important committees were appointed by the president, both to report at the next regular meeting. The first of these, consisting of Dr. Charles Peabody (chairman), Professor John H. Wright, Mr. W. K. Moorehead, Mr. F. W. Hodge, Mr. J. D. McGuire, is to investigate the question whether an improvement or a readjustment of the names used in archeology be feasible. The other committee, composed of Mr. F. W. Hodge (chairman), Mr. W. H. Holmes, Dr. Franz Boas, Dr. A. L. Kroeber, Dr. R. B. Dixon, Dr. George A. Dorsey, Mr. James Mooney, is to consider the most desirable nomenclature for Indian families north of Mexico.

The amendments to the constitution, as recommended by the council at its meeting in Philadelphia, in December, 1904, and in New York, in April, 1905, were adopted. The amended constitution, together with abstracts of all the papers read, will appear in the *American Anthropologist* for October–December, 1905.

Fifty-two new members were elected.

EXCURSIONS AND ENTERTAINMENTS.

On Tuesday, August 29, luncheon was tendered the association by Mrs. Phoebe A. Hearst, in the Department of Anthropology at the Affiliated Colleges, San Francisco.

In the afternoon an exhibition of the collections of the department was held. The officers of the department conducted the members of the association through the building and explained the collections.

On Wednesday, August 30, a luncheon was tendered the association by the California Academy of Sciences, at the St. Francis Hotel, Vice-President Alpheus Bull making an address of welcome.

In the evening of August 30, a dinner was given the visiting members of the association by the resident members, at the St. Francis Hotel.

On Thursday, August 31, before the opening of the morning session, Professor J. C. Merriam conducted a party to the Emeryville shell mound, explaining the excavations made in the mound by himself and Dr. M. Uhle.

On the same day, luncheon was tendered the association by Mrs. Phoebe Hearst, in the building of the Department of Anthropology of the University of California, at Berkeley.

After luncheon, the collection of plaster casts illustrative of ancient art was exhibited, as arranged, in this building.

On Friday, September 1, an excursion was made to Mr. Luther Burbank's home in Santa Rosa. This excursion was arranged through the courtesy of Mr. Burbank, the California Promotion Committee and the California Northwestern Railway. Thirty-four members took part.

On Saturday, September 2, an excursion was made to Leland Stanford Junior University. The buildings and grounds were shown the party and luncheon was tendered by officers of the university. Twenty members took part in this excursion.

RESOLUTIONS.

Resolutions, as follows, were unanimously passed by the association: Resolutions expressing appreciation of the courtesy and hospitality of Mrs. Phoebe A. Hearst; of the Academy of Sciences, and of Vice-President Bull and Director Loomis; of the University of California and President Wheeler; of Mr. Luther Burbank; and of the Leland Stanford Junior University; also expressing appreciation of the successful energy and direction of Professor Putnam, president of the association, and of Dr. Kroeber, secretary of the committee on program and arrangements; also by the visiting members, expressing their appreciation of the hospitality of the resident members.

PAPERS READ.

August 29, 1905.

Dr. Frederick Ward Putnam, director of the Museum of Anthropology of the University of California, and curator of the Peabody Museum of Harvard University: 'Exhibition of Bones, Possibly showing the Work of Man, from Quaternary Caves of California.' Discussed by Mrs. Herrick, Hill-Tout, J. C. Merriam.

Mr. Charles Hill-Tout, Ethnological Survey of Canada: 'Heterogeneity of the Culture of the Selish Tribes.' Discussed by Dixon, Goddard, C. Hart Merriam, Kroeber, Barrett.

Dr. C. Hart Merriam, chief of the Biological Survey, Washington, D. C.: 'The Aboriginal Indian Population of California.' Discussed by Mrs. Herrick, McLeod, Barrett.

Dr. R. B. Dixon, Harvard University: 'The Mythology of the Shasta-Achomawi Indians of California.' Discussed by Hill-Tout, C. H. Merriam.

Miss Constance Goddard DuBois, Waterbury, Conn.: 'Mission Religious Myths.' Illustrated with phonograph records. Discussed by C. H. Merriam, Peabody.

August 30, 1905.

Mrs R. F. Herrick, Eureka, Calif.: 'The Indians of Humboldt Bay.' Discussed by Hill-Tout, Keeler, Rust.

Dr. J. C. Merriam, University of California: 'The Exploration of Quaternary Caves in California.' Illustrated with lantern slides. Discussed by Peabody.

Dr. A. Hrdlicka, assistant curator, physical anthropology, U. S. National Museum: 'A Contribution to the Physical Anthropology of California.'

Mr. S. A. Barrett, University of California: 'Presentation of a Map showing the Territory, Divisions, Villages and Camp-Sites of the Pomo Indians of California.' Discussed by C. H. Merriam, Dixon.

Dr. C. Hart Merriam, Washington, D. C.: 'The Chievor of the Tongva, a Mortuary Ceremony.' Discussed by Miss DuBois, Dixon, Hill-Tout.

Mr. P. S. Sparkman, Valley Centre, San Diego County, Calif.: 'The Grammar of the Luiseño Language of Southern California.' Discussed by Hill-Tout.

Dr. Philip Mills Jones, secretary and editor of the Medical Society of the State of California: 'Brief Description of a Method for preserving Shell Specimens.' Discussed by Putnam.

Dr. Charles Peabody and Warren K. Moorehead, Archeological Museum of Phillips Academy, Andover, Mass.: 'The Naming of Specimens in American Archeology.' Discussed by Hill-Tout.

Dr. J. C. Merriam, University of California: 'The Excavations at Emeryville Shell Mound.' Illustrated with lantern slides. Discussed by Dixon, Hill-Tout, Putnam.

Mr. H. N. Rust, South Pasadena, Calif.: 'A Ceremony of the Mission Indians of Southern California.' Discussed by Kroeber, Miss DuBois, Hill-Tout, Putnam.

Dr. A. L. Kroeber, University of California: 'Exhibition of a Basket, now in the California Academy of Sciences, from the Extinct Indians of San Nicolas Island, California.' Discussed by McLeod, Rust.

Mr. F. I. Monsen, San Francisco, Calif.: 'Explorations in Northern Arizona and New Mexico.' Discussed by Putnam.

August 31, 1905.

Dr. A. L. Kroeber, secretary of the department of anthropology, University of California: 'Systematic Nomenclature in American Ethnology.' Discussed by J. C. Merriam, C. H. Merriam, Hill-Tout, Dixon, Peabody.

DR. C. HART MERRIAM, Washington, D. C.: 'Basket Cave Burial in California.' Discussed by McLeod, Putnam.

MR. H. N. RUST, South Pasadena, Calif.: 'The Obsidian Blades of Northern California.' Discussed by Putnam.

MR. S. A. BARRETT, University of California: 'Basket Designs of the Pomo Indians.' Discussed by C. H. Merriam.

DR. P. E. GODDARD, department of anthropology, University of California: 'Mechanical Aids to the Study and Recording of Language.' Discussed by Putnam.

DR. J. C. MERRIAM, University of California: 'Some Suggestions concerning the Origin of the Calaveras Skull.' Illustrated with lantern slides. Discussed by Hill-Tout.

MR. CHARLES KEELER, Berkeley, Calif.: 'Creation Myths and Folk Tales of the Manua Islands, Samoa.' Discussed by Dixon.

MR. J. T. GOODMAN, Alameda, Calif.: 'The Maya Dates.' Discussed by Putnam.

MR. C. C. WILLOUGHBY, assistant curator, Peabody Museum of Harvard University: 'Specimens in the Peabody Museum collected by the Lewis and Clark Expedition.'

MR. H. N. RUST, South Pasadena, Calif.: 'Exhibition of Implements from San Nicolas Island, used for Cutting and Working Shell Ornaments.'

PROFESSOR HOWARD SWAN, Imperial College, Peking, China: 'A Systematic Arrangement for Recording Dialects.'

PROFESSOR W. H. HOLMES, Washington, D. C.: 'Antiquity of Man in North America.' Discussed by Putnam, Peabody, Swan.

DR. F. C. NEWCOMBE, Victoria, B. C.: 'Exhibition of Northwestern Indian Designs.' Discussed by Hill-Tout.

BY TITLE.

MR. CHARLES F. LUMMIS, secretary of the Southwest Society, Los Angeles, of the Archeological Institute of America: 'Old Indian and Spanish Folk Songs of the Southwest.' Illustrated with phonograph records.

MR. C. P. MACKIE, Englewood, N. J.: 'A Plea for the more Critical Use of History in Anthropological Research.'

DR. GEORGE GRANT MACCURDY, Yale University: 'Eoliths from England and Belgium.'

DR. C. HART MERRIAM, Washington, D. C.: 'Basketry of California Indians.'

DR. ALBERT ERNEST JENKS, chief of the Ethnological Survey of the Philippine Islands, Manila: 'The Peopling of the Philippines.'

DR. A. L. KROEBER, University of California: 'Indian System of Consanguinity in California.'

MISS JEANNE ELIZABETH WIER, Nevada State University: 'The Washoe Indians of Nevada.'

DR. N. B. EMERSON, Honolulu, Hawaii: "Introduction to 'Unwritten Literature of Hawaii.'"

MRS. ZELIA NUTTALL, director of the Crocker researches in Mexico for the department of anthropology of the University of California: 'The Earliest Historical Communications between Japan and Mexico, from Original Documents preserved in Archives of Japan, recently brought to Light by a Mexican Diplomat.'

MR. ALVIN SEALE, Leland Stanford Junior University: 'Ceremonies relating to Sickness and Death in the Solomon Islands.'

MISS ALICE C. FLETCHER, Washington, D. C.: 'The Earth Lodge and its Migrations.'

MR. JAMES MOONEY, Washington, D. C.: 'The Cheyenne Indians.'

MR. JAMES MOONEY, Washington, D. C.: 'The Caloosa Tribe of Florida.'

DR. J. R. SWANTON, Washington, D. C.: 'The Social Organization of American Tribes.'

PROFESSOR W. H. HOLMES, Washington, D. C.: 'Architecture of the Aborigines of North America.'

PROFESSOR W. H. HOLMES, Washington, D. C.: 'Use of Copper by the Aborigines of North America.'

PROFESSOR W. H. HOLMES, Washington, D. C.: 'Problematical Objects in the Prehistoric Archeology of North America.'

It was voted that no program be proposed for the meeting of the American Association for the Advancement of Science, at New Orleans, and that the annual meeting be held at Ithaca, New York, in December, 1905.

GEORGE GRANT MACCURDY,
Secretary.

YALE UNIVERSITY MUSEUM,
NEW HAVEN, CONN.

SCIENTIFIC BOOKS.

Evolution, Racial and Habitudinal. By the Rev. JOHN T. GULICK. Washington, Carnegie Institution, August, 1905. 8vo. Pp. xii + 269; 3 pl.

Dr. Gulick for more than thirty years has been an earnest advocate of the importance of segregation of groups of individuals as an

element in the evolution of specific types. His papers have been useful in putting a needed emphasis on a factor which had been insufficiently taken into account and frequently overlooked by theorists concerned with the question of specific evolution. It was appropriate, therefore, that the Carnegie Institution should give him the opportunity of presenting in one handsome volume, the ripened result of his years of reflection and study on this subject.

It is known that his studies were largely due to the interest excited by the beautiful and multiform tree-snails of the Hawaiian Islands, which, for variety in characteristics elsewhere usually taken as of specific value, are unexcelled in any equal area. It was a problem which appealed to every collector of these attractive animals. How should this almost infinite variety under almost identical conditions be accounted for? The latest investigations indicate that the chief food of the arboreal Achatinellas consists of fungoid mycelium which in the warm air and constant rains of the mountainous region of the islands is more or less abundantly developed on the bark of trees and shrubs upon which these landshells live; an examination by Mr. Cook of many stomachs has shown that the leaves of the shrubs or trees form no part of their diet, and that, contrary to the opinions formerly held and even not altogether discarded in the volume under review, the species of tree upon which these animals live is not of importance in their economy; the same species of shell being often found indifferently upon different species of trees over the area the former inhabits. This fact lends even greater importance to the remaining elements of the environment among which the stimulus to variation is to be sought.

It has been found that the Achatinellas do not lend themselves readily to experiment. Removal, even when not the slightest injury has been inflicted, usually proves fatal, from some unexplained cause. It is evident that they are extremely sensitive to even minute changes in altitude, moisture, etc., and attempts to get them to breed in the more accessible regions of the islands, where they could be kept under continuous observation, have so far proved failures. Even the eggs seem unable to bear transportation.

For the reader who wishes to gain quickly an idea of the hypothesis maintained by Dr. Gulick, we should suggest the original papers of which a bibliography is given in the present volume, as they contain the meat of the matter in more concentrated form. In the opinion of the reviewer something has been lost by the considerable expansion of verbiage to which the statement of the hypothesis has here been subjected. But doubtless the special student of these recondite problems will find the volume none too long. In any event it should not be forgotten that while Dr. Gulick's views seem eminently probable and in the reviewer's mind go far toward accounting for many of the facts, nevertheless they are theoretical and have not yet been subjected to the crucial test of experiment, by which the proposed theory in the end must be tested. To justify final acceptation an hypothesis must not only be capable of accounting for the facts but it must be shown to be the only one by which they may be adequately explained. It is also necessary to determine how far the animals in question have arrived at that state of organic equilibrium which we recognize by the name of species. If, as has been held by some authorities, the small color-groups are really only of a temporary nature, and liable to immediate change upon subjection to modified environment, then the author's hypothesis, while losing nothing of its truth, is not a contribution to the evolution of species so much as to the physiology of color-variation. The latter may or may not be, in the group discussed, a factor of specific weight.

In any case we are grateful for the full presentation of the author's views which are of acknowledged importance in the discussion. The volume is well printed, though we could have wished that the colored plates had been of a better quality. W. H. Dall.

Marceli Nencki Opera Omnia. Gesammelte Arbeiten von Professor M. Nencki. Braunschweig, Friedrich Vieweg und Sohn. 1905.

Two volumes, with a portrait of the author. Pp. 840 + 890.

The influence which an untiring worker like Professor Nencki exerts on the development of science is perpetuated in at least two ways. The enthusiasm of the investigator is transmitted to his pupils and thus continues to live; and his definite contributions to knowledge are recorded in books which do not die with the author. With the methods of publication adopted in scientific circles of the present day, the researches of an individual are usually scattered in many papers and numerous journals. What this may mean in the course of thirty years of unceasing labor in the advancement of learning is illustrated in the case of Nencki's published work, embodying his studies in organic and physiological chemistry, in bacteriology, hygiene and pharmacology, presented in many places and in several languages. Nencki's interest continued to center in the chemical aspects of various allied branches of biological and medical science, although his writings are not strictly limited by such definition. No résumé or critical discussion of the literature of urea formation and the behavior of aromatic compounds in the animal body, of the chemistry of putrefaction, of the composition of the blood pigments, of the chemistry of various digestive secretions and processes and the activity of enzymes, would be at all adequate without reference to his published contributions. Furthermore, this does not take into account Nencki's many valuable investigations in organic chemistry and hygiene.

In view of what has been stated, and especially the personal circumstances which led to such diverse channels of publication, it is timely and appropriate that the life-work of this distinguished physiological chemist should be collected and presented in a more readily available form, thus supplying what an untimely death prevented on the part of the late scientist; and it is, indeed, fortunate that two pupils so well known and closely associated with Nencki as N. Sieber and J. Zaleski have undertaken the compilation of his collected works. The two volumes which they have edited embrace all of Nencki's scientific papers, together with abstracts of such investigations as were directly inspired by him and conducted under his supervision. A detailed reference to the papers would interest the specialist alone; but the array of contributions appearing in uninterrupted succession from 1869 to 1901 is an impressive monument to industry. A brief biographical sketch of the author is included in the volumes, which are of quite unusual typographical excellence.

LAFAYETTE B. MENDEL.
SHEFFIELD SCIENTIFIC SCHOOL OF
YALE UNIVERSITY,
NEW HAVEN, CONN.

Manual of Chemical Analysis as Applied to the Assay of Fuels, Ores, Metals, Alloys, Salts and other Mineral Products. By EUGÈNE PROST, D.Sc., of the University of Liège. Translated by J. CRUICKSHANK SMITH, B.Sc., F.C.S. Large 8vo. Pp. 300. Price $4.50. New York, D. Van Nostrand Company. 1905.

The work comprises a short introduction on the 'preparation of samples for analysis,' nearly two hundred pages on the analysis of fuels, waters and various native and artificial chemical compounds, and one hundred pages on the analysis of metals and alloys. According to the author's preface, it is intended as a manual for the industrial chemist.

Viewing the book in the light of its intended usefulness, our verdict upon it is that it is as nearly superfluous a work as could be written. The plan is fragmentary, many important analyses are omitted; the directions are poorly expressed, in most cases insufficient and in many inaccurate; obsolete methods are mixed in with more modern ones without criticism or discrimination; there is scarcely to be found a single reference to any other works on analysis or journals of any kind, to supplement the fragmentary information given; the translator was evidently as little fitted for his task as the author, as is evident from poorly translated phrases which betray an ignorance of English chemical expressions and especially of metallurgical terms; the paper is wretchedly poor, the bind-

ing flimsy, the typography bad, the cuts miserable.

The reviewer is not suffering from either indigestion or disordered liver, and on taking second thought is convinced that the above estimate is not undeservedly harsh.

JOSEPH W. RICHARDS.

Histoire de l'habillement et de la parure. By L. BOURDEAU. 1 vol. 8vo. Bibliothèque scientifique internationale. Paris, Felix Alcan. Pp. 300. 6 francs.

This volume completes a series of culture-historical studies by the author: The forces of industry, the history of alimentation, the conquest of the animal kingdom, the conquest of the vegetal kingdom, and history of dress and adornment. Three motives are urged as having given rise to vestment—protection from injury caused by the things that are without, the love of pleasure and modesty. The male sex and the female have vied with each other in the elaboration of innumerable inventions in this category. Animals have clothing provided by nature—carapaces, shells, hair, bristles, feathers, down, wool and more. Man's skin, on the contrary, is a tissue of sensation structures, putting him into lively contact and communication with the outside world, but shielding him little.

The unfolding of this story is divided into two parts: (1) the materials—skins and textile substances and their preparations, and (2) the history of costume. The substances fit for clothing are not innumerable. They had to be bad conductors of heat from the body and to the body; they had to be pliable, fitting themselves to the form, tough enough to wear and last and pay for the time spent in manufacturing them. The story begins with skins and passes on through animal textiles, vegetal textiles and other substances, from which must not be omitted the great variety of things ornamental. Add to all this the fashions in tissues, the dyeing, staining, painting, bleaching, printing of patterns on goods, cutting out, sewing and trimming, and it will appear what a large fraction of human hours are given to raiment. The making of buttons requires the services of 30,000 workmen and an outlay of 30,000,000 francs (1900).

The development of costume fills the last one hundred pages, its general evolution, the special history of modern costume, head dresses, foot gear and gloves, accessories of costume, such as handkerchiefs, fans, parasols, umbrellas and jewelry. There is a chapter (pp. 124–147) on artificial coloring of the hair and skin, tattooing, painting and dyeing. And the goodly friend of the species, soap, together with perfumeries, baths, etc., is not neglected. It is a great pity that there is no index to the work, for there is an infinite amount of petty detail gathered here, to which one would like to refer. The author assumes the existence of naked and unadorned peoples. When you go to look for them, they are seldom to be found, which leads to the inquiry whether really there are any such. O. T. M.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of the American Chemical Society for November contains the following articles:

ROY D. HALL and EDGAR E. SMITH: 'Some Observations on Columbium.'

JOSEPH H. GOODWIN: 'Electrolytic Calcium.'

GEO. A. HULETT: 'Preparation of Nitrogen from the Atmosphere.'

H. M. GORDIN: 'On the Crystalline Alkaloid of Calycanthus Glaucus.'

WILLIAM A. NOYES and HOWARD W. DOUGHTY: 'Derivatives of Trimethylparaconic and of Camphoronic Acids.'

EDWARD GUDEMAN: 'Artificial Digestion Experiments.'

A. T. LINCOLN: 'A New Burette Holder.'

Review of American Chemical Research.

The Museum News, of the Brooklyn Institute, for November may be termed a zoological number, as it is principally devoted to notes pertaining to that branch of science. There is a little leader in the matter of labels, which explains why labels are frequently absent, and also gives the point of view of the curator. The completion of a group of fur seals is announced which has been in preparation for some time, and is the finest of its kind in any museum, comprising as it does thirteen speci-

mens, representing the various classes of this valuable animal. The leading article in the Children's Museum section is a sketch of 'King Cole,' a live crow, which was for some time an object of interest in the museum. Lecture courses are announced for both museums.

SOCIETIES AND ACADEMIES.

THE ELISHA MITCHELL SCIENTIFIC SOCIETY OF THE UNIVERSITY OF NORTH CAROLINA.

THE 161st meeting of the society was held in the chemical lecture room on Tuesday (7:30 P.M.), October 17, 1905. The following papers were presented:

PROFESSOR H. V. WILSON: 'On the Formation of Regenerative Bodies of Sponges when kept in Confinement.'

PROFESSOR A. S. WHEELER: 'Paper Making.'

ALVIN S. WHEELER,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

MUSICAL INSTRUMENTS OF MALAYSIA AND THE WEST COAST OF AMERICA.

TO THE EDITOR OF SCIENCE: A short time ago the National Museum received from Mr. C. Boden Kloss, curator of the Johore Museum, No. 40 of the *Journal of the Straits Branch of the Royal Asiatic Society,* for June, 1904, containing an illustrated catalogue of the ethnographical collection of the Sarawak Museum, Part I., Musical Instruments, by R. Shelford.

On page 29, Mr. Shelford thus describes a flageolet of the tribe called Murut, in Borneo:

a. Murut—Flageolet. (Plate VIII., figs. 7 and 8.)

Distal end open and cut square, proximal end closed by the natural septum, the bamboo has not been cut flush with this but projects considerably beyond it; in the wall of this projecting part a small hole is bored quite close to the septum, and a groove runs on the outside of the flute from this hole to the sound-hole, the groove being covered by a slip of bamboo luted on with dammar. The edge of the sound-hole is sharpened by a piece of palm-leaf stuck on. The sound-hole is 5 centim. from the proximal end; there are two stops 8.5 centim. apart, bored with a red-hot iron in a flattened strip on the same side as the sound-hole, the upper one is 32 centim. from the sound-hole. Total length 52.5 cm.; diam. 2.5 cm.

Catalogue No. 1291. F. J. D. Cox, Esq. (P. viii 03). From the Trusan river.

This is precisely similar to the mystery flute of some of the early writings about the North American Indians. The Museum has just received an additional example from Arizona, through E. H. Nelson. They are usually made of cane, having a closed joint at or near the middle. A hole is pierced on either side of the septum of the joint through the walls of the cane and an air channel cut on the outside from one hole to the other. If the upper hole and the channel are covered by a bandage or the finger as far as the lower face of the septum and the upper tube blown into, it gives a whistling sound. In the lower section three or four finger holes are made. If more than that number, it shows a European influence. If an instrument of this kind that has no bandage is handed to one ignorant of its characteristics, he would not be apt to place a finger in the precise spot required to make a sound, and how to sound it would be a mystery to him. Some of the North American Indians construct bone whistles in the same manner. For the reason that this method of construction is seldom seen elsewhere, the instrument is supposed to have been original with the Indians of North America.[1]

This is another interesting connecting link between Malaysia and the west coast of America, because of these two identical instruments in regions far apart. A search for the cause of this identity will be interesting to ethnologists.

E. H. HAWLEY.

THE BUREAU OF SOILS.

TO THE EDITOR OF SCIENCE: Mr. F. H. King, in the last number of SCIENCE, reviewing the work done by Dr. Buckingham and published by the Department of Agriculture, makes use of the following expression:

He is well aware too that my object in having him called to the bureau was that he might make

[1] See George Catlin Indian Gallery, Smithsonian Report, 1885, p. 395 and Plate 93 g.

investigations along exactly the lines printed in the Bulletin, with many others, but to have him do so in conjunction with simultaneous field studies * * * etc.

To one who is unacquainted with either party to the controversy, on the nature of which he is also very little posted, the following questions naturally arise:

1. By what uncharted route under the civil service did Dr. Buckingham reach his present position in the Department of Agriculture?

2. Does one who secures a position in the department by the means implied, consider himself owned by one outside of the department, so that the latter shall complain, 'Is the creature greater than the creator?'

3. Is Dr. Buckingham owned in Madison, Wisconsin?

ARTHUR JOHN HOPKINS.

October 22, 1905.

SPECIAL ARTICLES.

THE METHOD OF ELIMINATION IN FIXING GENERIC TYPES IN ZOOLOGICAL NOMENCLATURE.

ONE of the most perplexing problems in zoological nomenclature is to decide on the proper application of a generic name used in a comprehensive sense by an early author, to one of the component parts of the original group. The genus of Linnæus and his followers of the eighteenth century corresponds fairly to the family of the twentieth century. It is agreed that a generic name should stand or fall by its typical species. But the writers of the eighteenth century had little conception of type-species in the modern sense. We must, therefore, find some method of fixing their types for them.

This may be done by choosing the 'best known European or officinal species,' to quote an expression attributed to Linnæus. When such a species is clearly indicated, this ought to settle the matter. But it does not do so in all cases, as some genera have no species either European or officinal. As many of the earlier writers took Linnæan specific names for their genera (tautonomy), it is safe to regard such a practise as fixing the type in question: *Bodianus bodianus* is an example of this sort. Virtual tautonomy (as *Tetrao tetrix, Scomber scombrus*) amounts to the same thing.

The method of beginning with a leading species or *chef de file,* as typical representative of each genus to be described in full, while the others were disposed of in comparative sentences, was adopted by Lacépède, Cuvier, Valenciennes, Poey and other authors. In ichthyology this has given reason for the choice of the type of the genus by page precedence. This method was raised to the dignity of a universal rule by Dr. Bleeker and others. It is a pity that it was not systematically adopted earlier, for it would have given fixity, a matter which in nomenclature far outweighs all others. But Linnæus, among others, usually placed his type-species in the middle of the series, the less known or more aberrant forms at either end of it.

The rule of the first reviser is generally recognized, and is given precedence over all other methods of fixing the type by many authors. The objection to it is that no one has yet defined the first reviser, so as to separate his rights from the rights of different meddlers. If we admit none to be revisers, unless they definitely limit a genus and definitely associate its name with some one or more of its original constituent species, to the exclusion of others, this rule may be available, although its application involves a good deal of otherwise profitless labor in bibliography.

In recent years a rule of fixing types by elimination has come into vogue, the American Ornithologists' Union having given it especial prominence. As a guide to the operations of a first reviser, who finds no type assigned by previous writers, the rule is not open to serious objection.

But it has been largely applied without regard to previous revisers, and the meanings of various generic names have been frequently shifted in accordance with its supposed demands. It is evident that it is in great need of definition.

For example, let *A, B, C, D* represent the species of a comprehensive genus called *X*. If each of these is successively made the type of a new genus *U, V, Y, Z,* then *Z,* the last

of these, is invalid and its type, *D*, becomes the proper type of *X*. This is the simple condition of the problem. But let *A* and *C* be set off to form a new genus; *C* and *D*, another. Let a new genus be formed which would probably include *B* in it. Let still another be framed which might possibly include *D*. Let it be further uncertain whether *A* and *B* should be placed in different groups. Let still another writer definitely connect the old genus with *A*, while another uses it, not for any of its constituents, but for some new form probably congeneric with *B*, and you have a not unusual statement of the problem.

There is no way out of this by the rule of elimination. By accepting the first reviser rule, itself subject to the Linnæan rule and the rule of tautonomy, we may well fall back on the rule of page precedence, and let the rule of elimination be simply a recommendation to the first reviser, without direct validity of its own. This is the position of the rule of elimination in the new International Code.

I give two concrete illustrations of the difficulties of the rule of elimination among genera of fishes.

The genus *Clupanodon* Lacépède, 1803, was based on 'toothless herrings,' the *chef de file* being *Clupanodon thrissa*. This species as described by Lacépède, is the *Clupea thrissa* of Broussonnet, the American species, later called *oglinus* by Le Sueur. This is, however, not the original *Clupea thrissa* of Linnæus, 1758, which was based on the *Clupea thrissa* of Osbeck, 1757, a Chinese species, later called *Clupea nasus* by Bloch, a species of *Konosirus*. The second species of Lacépède, *nasicus*, is the same as *Clupea nasus* of Bloch. The third, *pilchardus*, is the *Clupea pilchardus* of Linnæus, a species of *Sardinia*, which is probably the same as *Sardinella*. The fourth species of Lacépède, *sinensis*, is apparently the species called later *Clupea ilisha*, and is probably not the original *sinensis* of Linnæus. It is a species of *Clupeonia* or *Harengula*. The fifth, *africanus*, is a species of *Ilisha*, and the sixth, *jussieui*, is the original type of the genus *Clupeonia*.

Arranging these according to the modern genera:

1. *thrissa*. The type of *Thrissa* Rafinesque, 1815, the name given as a substitute for the hybrid name *Clupanodon*.
   Chatoëssus Cuvier, 1817, based on Lacépède's *thrissa*, the generic name later transferred by Valenciennes to *punctatus*, the *thrissa* of Linnæus.
   Opisthonema Gill, 1863, based on *thrissa* of Lacépède = *oglinus* of Le Sueur.
   Konosirus Jordan & Snyder, 1900, based on *punctatus* Schlegel, which is a congener of *Clupea thrissa* Linnæus (= *Clupea nasus* Bloch) and not of *Clupanodon thrissa* Lacépède, which is *oglinus* of Le Sueur. Most writers unite *Konosirus* with *Dorosoma* Rafinesque, 1820; but the two are probably distinct.
2. *nasicus*. This is the original *thrissa* of Le Sueur and is congeneric with *Konosirus punctatus*.
3. *pilcharus*. This has never been made type of a genus. It is certainly congeneric with *Sardinia* Poey, 1870, with *Amblygaster* Bleeker, 1855, and I now think with *Sardinella* Valenciennes, 1845. Most writers (wrongly I think) unite all these with *Clupea* Linnæus, 1758.
4. *sinensis*. This is referred by Valenciennes to *Clupeonia* Valenciennes, 1845; which genus is probably identical with *Harengula* Valenciennes, 1845, earlier page. Most writers (I think wrongly) place it in *Clupea*.
5. *africanus*. This is congeneric with the type of *Ilisha* Gray, 1836, and with that of *Pellona* Valenciennes, 1845. It has never been taken as type of a genus.
6. *jussieui*. Type of *Clupeonia* Valenciennes, 1845, apparently congeneric with types of *Harengula* and *Kowala* of the same author on earlier pages. Usually referred to *Clupea*.

By the first 'reviser' after Lacépède, Rafinesque, 1815, *Thrissa* is substituted for *Clupanodon*, and Lacépède's *thrissa* is doubtless to be taken as Rafinesque's type. By the next, Buchanan, 1822, *ilisha* (= *sinensis* Lac.) is described as a new species of *Clupanodon*. The genus *Clupanodon* then dropped out of notice until revived by Dr. Jordan in 1882, by a process of elimination for *Clupeonia jussieui*. Later the same writer, by another process of elimination, substituted *Clupanodon* for *Sardinia*. Still later, by the same process with further light, the newly defined genus *Konosirus*, being congeneric with *Clupanodon*

nasicus, was suppressed in favor of *Clupanodon.* The change of result depends on the status assigned to *Konosirus, Sardinia* and *Clupeonia.* By the process of elimination the name *Clupanodon* can bé used for any one of several species, its use depending on the views one may hold of these closely related generic or subgeneric types. If restricted to the *chef de file,* the matter is at once settled. The species involved become:

Clupanodon oglinus.
Konosirus thrissa.
Sardinella pilchardus.
Harengula ilisha.
Ilisha africana.
Harengula jussicui.

The rule of the first reviser, if the rule of the *chef de file* be disregarded, would cause *Clupanodon* to replace *Harengula, Clupeonia* and *Kowala, jussieui* being its type.

Another illustration is taken from the genus of flounders, *Pleuronectes* Linnæus, 1758.

In this genus, the European species mentioned by Linnæus and by Artedi, from whom the genus is derived, are:

hippoglossus (type of *Hippoglossus* Cuvier, 1817).
platessa (type of *Platessa* Cuvier, 1817).
flesus (type of *Flesus* Moreau, 1873, a genus very close to *Platessa,* perhaps, in fact, identical).
limanda (type of *Limanda* Gottsche, 1835).
solea (type of *Solea* Quensel, 1803, of *Solea* Rafinesque, 1810, and of *Solea* Cuvier, 1817).
rhombus (type of *Rhombus* Cuvier, 1817, name preoccupied:. of *Rhomboides* Goldfusz, 1820, substitute name; also, as *Bothus rumolo,* the first species named under *Bothus* Rafinesque, 1810).
maximus (type of *Psetta* Swainson, 1839, not *Psettus* Cuvier, 1817; first species named of *Scophthalmus* Rafinesque, 1810, which includes also *rhombus*).
passer (a synonym of *flesus*).

Scophthalmus and *Bothus* are based on three species each, the two categories being essentially the same, *Scophthalmus* being based on literature, *Bothus* on specimens. But the order is changed in the two cases, *maximus* occurring first under *Scophthalmus, rumolo* (*rhombus*) under *Bothus.* Under *Rhombus* and *Bothus* and *Scophthalmus,* both *maximus* and *rhombus* are included, and *Psetta,* although based on *maximus* alone, by implication is a substitute for *Rhombus.*

The first reviser, Rafinesque, 1810, leaves no species in *Pleuronectes,* unless, as he refers all the other species to other genera, we might regard *hippoglossus,* which is not mentioned by him as the type of his *Pleuronectes.* The next reviser, Cuvier, 1817, recognizes the genus, *Pleuronectes* as used by Linnæus, but at once separates it into four genera or subgenera dropping the original name. These are *Platessa* (*platessa, flesus, limanda*), *Hippoglossus* (*hippoglossus*), *Rhombus* (*maximus, rhombus*) and *Solea* (*solea*). Meanwhile *Solea* had been set off previously by Quensel (1803) and by Rafinesque (1810), the latter author very erroneously referring to it, *platessa, flesus* and *limanda* also. Swainson, 1839, the next reviser, recognizes *Pleuronectes* (*platessa*), *Hippoglossus* (*hippoglossus*), *Psetta* (*maximus*) and *Solea* (*solea*). This is the first restricted use of *Pleuronectes* since the time of Linnæus and his followers. Later *Pleuronectes* was restricted by me to *maximus* by the rule of elimination, *flesus* being then regarded, as it is still regarded by most authors, as congeneric with *platessa. Limanda* is also near *platessa.* But neither *limanda* nor *flesus* is the 'best known European species' of the Linnæan genus *Pleuronectes.* The rule of the first reviser would fix *Pleuronectes* with *platessa,* the rule of the best known species with *platessa* or *maximus,* the rule of elimination would place *flesus* as type of *Pleuronectes,* if defined as dealing with a species at a time. But Rafinesque took out *solea, platessa* and *flesus* together, to form his genus *Solea,* leaving only *hippoglossus* not provided for. This fact, some would hold, restricts *Pleuronectes* to *P. hippoglossus.* Cuvier next took out all the species, leaving no genus *Pleuronectes,* and placing *Rhombus* last, next to *Solea.* On the other hand, *platessa* was placed first by Cuvier, its subgenus *Platessa* being apparently the *chef de file* subgenus in Cuvier's genus *Pleuronectes.*

With this group nothing in particular can

be settled by the process of elimination unless we agree beforehand as to whether *Flesus* is a valid genus, or as to what were the unexpressed purposes of Rafinesque.

But common usage and common sense agree in placing *platessa*, the common Plaice, as the type of *Pleuronectes*.

DAVID STARR JORDAN.

AN INTERESTING CRETACEOUS CHIMÆROID EGG-CASE.

ALMOST nothing is known of the structural characteristics of the holocephalous fishes of the Mesozoic period except dental plates or teeth. The remains of such, however, are numerous and about a score of generic names have been proposed for them, although A. Smith Woodward only fully recognizes five, *Ganodus, Ischyodus, Edaphodon, Callorhynchus* and *Elasmodectes*. I was, therefore, much interested in a fossil which Drs. Frank H. Knowlton and T. W. Stanton referred to me for identification, if possible, and which I at once recognized as a chimæroid ovicapsule apparently most nearly resembling that of modern deep-sea forms.

The interest arises from the assumption that where likeness prevails between such products, not only the parts which frame them but other structures must correspond. The inference is not irrefragable, but in the absence of contradictory data, perfectly legitimate as a provisional hypothesis at least.

The fossilized egg-cases previously known are few and the indications as to affinities interesting as well as important. Three figures have been published of Jurassic egg-cases, two by Emil Bessels and one by Otto Jaekel. All are of the *Callorhynchus* type and it is significant that a 'right palatine tooth,' obtained from the 'Lower Greensand' of New Zealand, has been attributed by E. T. Newton and Woodward to that genus and named *Callorhynchus hectori*.

The newly found fossil was obtained by Mr. N. H. Darton, of the U. S. Geological Survey, from 'massive sandstone' a few miles west of Laramie, Wyoming.

The contour and general form are well preserved but not the details. The resemblance to the ovicapsules of *Harriotta* and *Rhinochimæra* lies in the absence of differentiation between the anterior and posterior portions of the lateral alæ of the capsule and the uniformity of the transverse costal ridges all through. It differs from the ovicapsules of both *Harriotta* and *Rhinochimæra* by the greater width of the alæ and especially the greater width and extension forward along the sides of the archidome.[1] The resemblance is greatest to *Rhinochimæra*.

The genus *Harriotta* was set apart as the type of a subfamily (Harriottinæ) by Gill, in 1896, and it was associated with *Rhinochimæra* in a family (Rhinochimæridæ) by Garman, in 1904. It is to this group (if a family, properly nameable Harriottidæ) that the Wyoming fossil belongs. It can not be correlated with any one of the many generic names (*Eumylodus, Mylognathus, Dipristis, Sphagepœa, Diphrissa, Bryactinus, Isotænia* and *Leptomylus*) that have been especially coined for American Cretaceous fossils, but the naming of it, if such must be done, I leave to Dr. Dean who is now publishing (through the Carnegie Institution) an elaborate work on the chimæroids. I have had the privilege of looking over the proof-sheets of that work and my knowledge of the ovicapsules of the Harriottidæ is chiefly derived from it, though I had long ago seen those of *Harriotta*.

If these determinations prove correct and the groups named families by Garman are accepted as such the curious deduction follows that no fossil ovicapsule of a typical chimærid has been found as yet.

Although the living harriottids are deep-sea forms, it does not follow that a deep sea is indicated for the habitat of the extinct harriottid. The character of the sandstone as well as of the basin in which the ovicapsule was found is opposed to the hypothesis of a deep sea. It must be remembered, too, that the same genus may have species ranging from shallow water to abyssal depths; *Chimæra*, for example, has a species (*C. colliei*) which may be caught from a city wharf and

[1] In the interest of conciseness of description I would use *archidome* for the chamber for the head and trunk of the chimæroid and *urodome* for that receiving the caudal portion.

another (*C. affinis*) which may descend to a depth of at least 1,300 fathoms.

THEO. GILL.

ELECTROMETER FOR THE STAGE OF THE MICROSCOPE.

THE capillary electrometer consists of a vertical tube drawn out at the lower end into a fine capillary and filled with mercury (Figs. 1 and 2). The upper end of the tube is joined to a cylinder in which a piston is

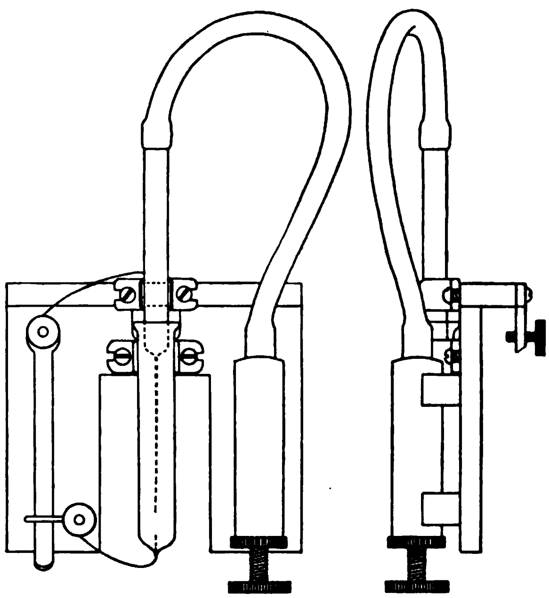

FIG. 1. FIG. 2.

moved by a screw, thus making pressure on the mercury column. The end of the capillary dips in a reservoir containing 20 per cent. sulphuric acid. A little mercury is placed in the reservoir. Platinum wires lead from this and the mercury in the capillary to convenient binding posts. When mercury is placed in the vertical tube it enters the capillary until the weight of the column of mercury is balanced by the surface tension. If the capillary be now dipped in the reservoir containing the sulphuric acid and the piston driven upward by its screw, mercury will be forced out of the capillary into the acid, and on lowering the pressure the mercury will retreat within the capillary, drawing the acid after it. As the mercury in the capillary is kept from falling by the surface tension, it is obvious that whatever increases or diminishes the surface tension, for example an electric current, will raise or lower in corresponding measure the mercury in the capillary. The alteration in surface tension is accompanied by the movement of ions between the meniscus and the remaining electrode of the electrometer (the mercury in the acid reservoir). In practise it is found that this movement can be neither very rapid nor long continued, without injuring the sensitiveness of the instrument. The potential difference from even a single element (Daniell or dry cell) is far too large to be used safely. It is advisable to employ a potential divider, or rheochord, which shall permit only a fraction of the original potential (not more than 0.1 volt) to reach the electrometer.

The electrometer should be kept short-circuited, except during an observation, so that the capillary and the mercury in the reservoir may always be connected through a conductor. The short-circuit key is shown in Fig. 1. A strip of spring brass connected with one of the binding posts of the electrometer rests against a second piece of brass connected with the other binding post, except when depressed by the finger. The point of higher potential, when known, should always be connected with the capillary.

When the capillary electrometer is connected with two points of unlike potential the meniscus is displaced. The pressure necessary to bring it back to its original position is proportional to the electromotive force that displaced the meniscus. Thus by connecting the electrometer with known differences of potential it may be experimentally graduated. In practise, the relation between the pressure and the potential must frequently be redetermined. It is usually easier to measure differences of potential, such as the demarcation current of nerve or muscle, by compensation. In this method the electromotive force of the demarcation current is measured in fractions of a Daniell cell, or any other constant element, by bringing into the same cir-

cuit with the current of injury, but in an opposite direction, so much of the current from the cell as will exactly balance the current of injury, *i. e.,* so much as will keep the meniscus of the electrometer from moving in either a positive or a negative direction when connected with the circuit.

Numerous advantages are presented by the form of electrometer here shown. It fits the stage of the microscope. The microscope need not be tilted very far, and the observer is therefore in a comfortable position. The position of the electrometer on the stage may readily be changed. All the parts near the acid are of hard rubber, thus excluding currents that might arise from acid touching metal parts. The acid tube is flanged so that the acid can not creep out along the capillary tube. The capillary can easily be brought against the wall of the acid tube. The tube from which the capillary springs descends within the acid tube, thus protecting the capillary against breakage. Either tube may at once be removed from its holder. The platinum wires extend to the binding post, and are not simply short pieces soldered to copper wire. The wire to the capillary tube extends to the bottom of the tube, thus maintaining the contact until all the mercury in the tube is used.

About one cubic centimeter of paraffin oil should be placed above the piston. Only absolutely clean double-distilled mercury should be used.

W. T. PORTER.

HARVARD MEDICAL SCHOOL.

QUOTATIONS.

RESEARCH WORK IN GREAT BRITAIN.

EXPLAIN some remarkable discovery of pure science to the ordinary man and he instantly wants to know what is the use of it or casts about for some way of utilizing it for profit. He neither understands very clearly how the discovery was arrived at nor the importance it possesses apart from immediate application to the meeting of daily wants. Yet nothing is more certain than that the applications of science which most fully subserve the wants of man depend in every considerable case upon the results obtained by men who had no practical application in view. He who finds out merely for the sake of finding out everything that can be known about a given subject has so far contributed to laying the foundations of advance as it is understood by the practical man. Without the discoveries thus made the practical man finds himself balked at every turn. For practical applications depend upon the combination of a great many factors, and demand a power of selection from a vast body of ascertained facts which are supplied only by the seeker after knowledge for its own sake. Of the knowledge thus acquired no man can say what part will be first utilized, or how long any portion may remain useless for practical purpose. That depends very much upon the progress made by research in other directions, hence many important results have been lost to sight merely because some link was missing in the chain connecting them with other known facts. In that case they have to be rediscovered, otherwise they in turn become the missing links, and for want of them other knowledge remains sterile.

Now it is too true that in this country, as Professor Nuttall complains, research is not a career. Pure science does not bring bread and butter. This country has often been fortunate in having men of means who devoted themselves to research for the love of truth, and it has had men like Faraday, of great simplicity of life, who were not merely content, but glad, to live on the income of a clerk while making discoveries that subsequently changed the face of society. But we can not depend upon a constant and adequate supply of either type. The field is now very large and very costly to work. There are many temptations to turn aside which we must expect to be too much for most men who do not possess compelling genius. Hence, if we do not provide a living wage and adequate equipment for a sufficient number of seekers after knowledge, we must expect to be beaten in practical affairs by nations which better understand their true interests. The London school loses promising men who go into practice. In one way or another every branch of research loses promising men, who either go into

practical affairs with what knowledge they have or make research itself subservient to money-getting by selling crude inventions, by self-advertisement, or by cooperation with financiers. We have no hierarchy of students on a living wage basis; and as a consequence we are very short of real teachers even for practical purposes. For the real teacher must be an advanced student, not a mere parrot reciting other men's work.—The London *Times*.

FALLS OF METEORS.

Dr. Edward S. Holden, of the U. S. Military Academy, has kindly sent us the following letters for publication:

A large meteor appeared at Leoti, Kans., between the hours of nine and ten the night of September 2. The sky was clear and the air cool. The meteor, or fire ball, appeared in the west at an angle of about forty-five degrees, crossed the heavens with a hissing sound and was lost in the east, about ten degrees above the sky line. It seemed large as a full moon, with ragged edges. For a moment everything was flooded with light. I think a full minute passed before thundering began in the east and following the path of the meteor across the heavens slowly died out in the west. I have seen meteors in this country at different times, but none as large or followed by thunder.

October 9, 1905. M. A. Marston.

A meteor is said to have fallen some years ago about fifty miles from here beside White Whale Lake. It is near an Indian reservation, and the Indians profess to have seen it fall, and hold it in a good deal of reverence. I have not yet seen the object, * * * I drove out to see the stone this summer, but found that it meant a long row up the lake in a very indifferent boat, so I put the excursion off till the ice comes, when it will be possible to drive right to the spot. Are there any observations that I could make upon this meteor, if it proves to be such, that you would care to have? If so, kindly let me know.

Chas. H. Huestis.

Edmonton, Alberta,
October 5, 1905.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY AND HARVARD UNIVERSITY.

We learn from the Boston *Transcript* that Harvard University has now formally abandoned all plans for a merger with the Massachusetts Institute of Technology. This action was taken at a meeting of the president and fellows on October 30, when the following letter was presented:

My dear President Eliot:

I am directed by the Corporation of the Institute of Technology to communicate to you the fact that, in view of the recent decision of the Supreme Court of the State in the case of John Wilson et al. *vs.* The Massachusetts Institute of Technology, the Corporation of the Institute finds it impossible to proceed with the plan of cooperation which was considered at its meeting of June 9.

In communicating this fact the corporation desires at the same time to express its appreciation of the fairness and courtesy of the Corporation of Harvard University in our common effort to solve a difficult question.

I am,
Very sincerely yours,
[Signed] Henry S. Pritchett,
October 11, 1905. *President.*

Thereupon it was voted that the committee of conference appointed by the Harvard board on May 16, 1904, at the instance of the corporation of the Massachusetts Institute of Technology, be discharged, and that the president be requested to express to the members of the two committees of conference the high appreciation by the president and fellows of the foresight, good judgment and public spirit of which the committees' project for a close affiliation between the institute and the university gives evidence, and the regret of the president and fellows that the project has been brought to naught by the recent decision of the supreme court, which makes it impossible for the institute to place itself beside the university.

SCIENTIFIC NOTES AND NEWS.

The Bolyai prize of the Hungarian Academy of Sciences, of which some account was recently given here, has been awarded to M. Poincaré.

THE eightieth birthday of Dr. F. A. March, professor of English and comparative philology at Lafayette College, was celebrated on October 25, when Professor W. B. Owen made an address of congratulation. The trustees of the college have offered to retire Professor March with full salary, but he prefers to continue his usual duties.

DR. ARTHUR STÄHLER, assistant in the chemical laboratory of the University of Berlin, has been sent by the minister of education to Harvard University to pursue studies in inorganic chemistry under Professor T. W. Richards.

MR. HENRY S. DRINKER, recently installed as president of Lehigh University, was given the degree of Doctor of Laws by Lafayette College on October 25.

DR. EDWARD MARTIN, director of the Department of Public Health and Charities of the city of Philadelphia, has resigned this position.

DR. WILHELM WUNSTORF has been appointed district geologist in the Berlin Geological Bureau.

MAJOR LACHLAN FORBES has been appointed secretary of the Royal Scottish Geographical Society in succession to Major Lindsay Forbes.

THE special board for biology and geology has nominated Mr. F. A. Potts, B.A., of Trinity Hall, Cambridge University, to use the university table at Naples for six months.

DR. THEODOR PREUSS, of the Berlin Museum of Ethnology, has been sent on a scientific mission to Mexico.

MR. EINAR MIKKELSEN, a Dane, proposes to make an expedition to the Arctic regions, the objective being that part of the Polar Ocean which lies immediately to the west of the Parry Archipelago, north of Canada.

MR. S. P. JONES, formerly assistant state geologist of Georgia, has been pursuing special studies in petrography for the past six months, first at the University of Wisconsin and during the summer at Cambridge, Massachusetts, working on material loaned him by the geological department of Harvard University.

MR. LOUIS M. PRINDLE, of the U. S. Geological Survey, has returned from the Alaskan field, where during the past summer he has been making a geologic reconnaissance between the International Boundary and Fairbanks.

DR. CHAS. H. SHAW, professor of botany at the Medico-Chirurgical College of Philadelphia, has returned recently from a second expedition to the Selkirk Mountains, in British Columbia. The region of the big bend of the Columbia River, a large tract of country between the 51st and 52d degrees of N. Lat. and embracing the Selkirks has hitherto been almost unknown botanically and very imperfectly so geographically. Dr. Shaw's expedition, under the auspices of the Medico-Chirurgical College and including a number of students of botany and zoology mainly from the vicinity of Philadelphia, this year, as last, visited the big-bend region and collected some 25,000 sheets of specimens representing its flora, besides gathering data by photographs and weather readings bearing on the ecological features of this little-known mountain range.

AT a meeting of the Pharmaceutical Society of Great Britain on November 7 Sir George Watt delivered a lecture on shellac, and Mr. J. C. Umney, F.C.S., contributed a paper on the chemistry and analysis of shellac.

A SERIES of addresses on educational problems will be given under the auspices of the Department of Education of the City of New York, in Cooper Union on Wednesday evenings from November 8 to December 27. Among those who will lecture are Dr. Andrew S. Draper, New York state commissioner of education; Dr. W. H. Maxwell, superintendent of schools; Professor L. H. Bailey, director of the Cornell College of Agriculture; President Carroll D. Wright, of Clark College; Dr. L. H. Gulick, director of physical training in the city schools; Mr. Frank A. Vanderlip, the banker, and Dr. James H. Canfield, librarian of Columbia University.

UNDER the auspices of the Ethical Society of St. Louis, W J McGee, director of the St. Louis Public Museum, is giving a course of weekly lectures on anthropology to a class of twenty-five or thirty. The course presents a systematic outline of human development,

with special attention to the view that progress in culture is in accordance with definite natural laws. The class meets on Thursdays at four P.M. in the Museum of Fine Arts, Nineteenth and Locust streets; the first meeting occurred November 2. The details were arranged by Mrs. D. W. Knefler, secretary of the class.

A MONUMENT in honor of Z. Gramme, known for his discoveries in electricity, will be erected at Liège, near which city he was born.

MAJOR GENERAL SIR CHARLES WILSON, K.C.B., F.R.S., director-general of the British Ordnance Survey and of military education, known for his work on topography, died on October 25 at the age of sixty-nine years.

THE death, in his eighty-first year, is announced from Alsfeld, in Oberhessen, of Karl Müller, author of works on natural history, written conjointly with his brother.

DR. KOSTLING, vice-director of the Meteorological Bureau at Vienna, died on October 7.

THE inaugural meeting of the British Science Guild formed in April, 1904, was held on October 30, at the Mansion House. The objects of the guild are (1) to bring together as members of the guild all those throughout the empire interested in science and scientific method, in order, by joint action, to convince the people, by means of publications and meetings, of the necessity of applying the methods of science to all branches of human endeavor, and thus to further the progress and increase the welfare of the empire; (2) to bring before the government the scientific aspects of all matters affecting the national welfare; (3) to promote and extend the application of scientific principles to industrial and general purposes; (4) to promote scientific education by encouraging the support of universities and other institutions where the bounds of science are extended, or where new applications of science are devised.

A CONFERENCE of delegates from the corresponding societies affiliated with the British Association was held in the rooms of the Linnean Society, London, on October 30 and 31, under the presidency of Dr. A. Smith Woodward, F.R.S.

A CITIZEN of Denmark has given sufficient money to provide for a biological station in Greenland, and it is expected that the Danish government will defray current expenses.

BRITISH journals state that the Heriot trust governors have decided to establish a laboratory at the Heriot Watt College, Edinburgh, for the study of bacteriology in its relation to various industries. The laboratory has been fitted with the best appliances, and the services of Dr. Westergaard have been retained to supervise it. The laboratory was formally opened by a lecture by Professor Hansen, on October 18.

THE Physico-Chemical Club of Boston and Cambridge held the first meeting this autumn on November 1 in the Harvard Union. Professor Wilhelm Ostwald was present and was elected an honorary member. Professor T. W. Richards and Professor A. A. Noyes were reelected, respectively, president and vice-president, and Dr. G. S. Forbes was elected secretary and treasurer. Sixty-three members were present, who listened to a paper by Professor Noyes on the 'Hydrolysis of Ammonium Acetate and the Ionization of Water at 100°, 156° and 218°,' as well as one by Professor Richards on compressibility in relation to atomic volume and structure. Each paper was based upon entirely new data, and was followed by lively discussion.

ACCORDING to a telegram received by the Japanese consul-general in Copenhagen, the Japanese government will shortly send a special expert to Copenhagen and to the Baltic and North Sea waters in order to study the methods of carrying out international sea exploration.

THE removal of the Heidelberg University library, containing more than 700,000 volumes, into a new sandstone library building has just been completed. Each separate book was freed from dust by a cleaner operated by an electric motor, of the form used in house and carpet cleaning, the back and edges of each book being subjected to the powerful suction of the cleaner. The library requires about 21 miles of shelf room.

THE geological department of the British Museum has recently purchased and placed on exhibition a fine specimen of *Ichthyosaurus acutirostris* Owen, from the Upper Lias of Holzmaden, Wurtemberg. The specimen is remarkable as containing between its ribs the skeletons of no less than six fœtal young, as in the cases described by E. Fraas. It is supposed that these skeletons have been displaced from their natural position by crushing during the process of fossilization. On the other hand, it may be suggested that they in their struggles forced a way into the body cavity, and were thus, perhaps, the cause of their mother's death. Beddard has lately described such an instance in the recent skink, *Chalcides lineatus* (*Proc. Zool. Soc.*, London, 1904, II., p. 145); he, however, admits the possibility that extra-oviducal fœtation may be normal in some reptiles, and 'may be in part responsible for some of the legends concerning the swallowing of their young by various reptiles for protection's sake.'

THE experimental locomotive of Purdue University, Schenectady No. 2, which has recently served in an important study designed to determine the value of very high steam pressures, is to be sent to the Schenectady works of the American Locomotive Company early in November for the purpose of being fitted with a Cole superheater. It is expected that the engine will be returned with its new equipment early in January. During the absence of Schenectady No. 2 from the testing plant, a New York Central Atlantic type engine is to be installed upon the plant for use under the direction of the Master Mechanics' committee on front-ends. It is the purpose of this committee to repeat upon an engine of large size the experiments made under the patronage of the American Engineer upon Schenectady No. 2, for the purpose of determining the constants in such equations as may be necessary to the logical design of all portions of the front-end mechanism. The Master Mechanics' committee having the matter in charge consists of H. H. Vaughan, superintendent motive power, Canadian Pacific Railway, chairman; Mr. F. H. Clark, general superintendent motive power, C. B. & Q. R. R.; Mr. Robert Quayle, superintendent motive power and machinery, C. & N. W. Railway; Mr. A. W. Gibbs, general superintendent motive power, Pennsylvania Railroad; Mr. W. F. M. Goss, Purdue University; Mr. G. M. Basford, American Locomotive Company.

THE first course of lectures for the season 1905–1906 to members of the American Museum of Natural History will be given according to the following program. The lectures will be delivered on Thursday evenings at 8:15 o'clock, by members of the scientific staff of the museum and will be fully illustrated by stereopticon:

November 9, Mr. Frank M. Chapman, 'The Bird Life of Florida.'

November 16, Mr. Louis P. Gratacap, 'Newfoundland: Its Scenery and People.'

November 23, Dr. Edmund Otis Hovey, 'Northern Mexico: Its Deserts, Plateaux and Canyons.'

December 7, Professor Henry Fairfield Osborn, 'The Museum's Rocky Mountain Explorations of 1905.'

December 14, Professor Albert S. Bickmore, 'The Philippines—Manila.'

December 21, Professor Albert S. Bickmore, 'The Philippines—Luzon.'

The Army and Navy Journal calls attention to the fact that among the most valuable results of the American military occupation of the Philippines is the large and growing collection of maps of the islands prepared by officers of the army. These maps show in detail the roads, trails, rivers and mountain passes in nearly every part of the archipelago, and had they been in existence when the army began its campaign of pacification in the territory the difficulties of that undertaking would have been greatly lessened. During the domination of the Spanish little or nothing was done in that line, and they never had an accurate map, even of the larger islands. Nearly all the maps, such as they were, were prepared by the friars, whose work was performed without regard for its usefulness in military operations. But when the United States Army entered the territory it immediately instituted a comprehensive system of map making, with

special reference to military needs, and the result is a collection which, while it would be invaluable in the event of another military campaign, will also be highly useful in the peaceful development of the islands through the medium of modern roads, bridges and other improvements. These maps will probably do as much to promote the agricultural and industrial development of the Philippines as any single act of the civil government, and for them the authorities are indebted entirely to the patient, painstaking, courageous labors of the army.

THE council of the Royal Meteorological Society has now appointed a lecturer who is prepared to deliver lectures on meteorological subjects, *e. g.,* How to observe the Weather; Weather Forecasting; Climate; Rainfall; Thunderstorms; Meteorology in relation to Agriculture, Health, etc. The lectures will be illustrated by lantern slides from the large collection in the possession of the society. The council is willing to arrange for exhibiting at the gatherings of local scientific societies, institutions or schools, a collection of photographs, diagrams and charts illustrating meteorological phenomena and various patterns of instruments used for meteorological observations.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. ANDREW CARNEGIE recently offered $20,000 to Hope College, Holland, Mich., for a gymnasium, on condition that a like sum be raised by the institution. The condition has been met and the gymnasium is now being erected.

MR. RALPH VORHEES, of Clinton, N. J., has given Huron College, a Presbyterian institution in South Dakota, a hundred thousand dollars, subject to a life annuity of five per cent.

THE University of Melbourne will celebrate its jubilee in April, 1906.

DR. AUSTIN SCOTT has resigned the presidency of Rutgers College, but retains the chair of history and political science.

THE following appointments have been made in the faculties of the George Washington University:

Faculty of Graduate Studies.

General Henry L. Abbott, U.S.A., retired, member of the Board of Consulting Engineers of the Panama Canal, professor of hydraulic engineering.

Edward B. Rosa, Ph.D. (Johns Hopkins), professor of physics.

Brigadier-General George M. Sternberg, U.S.A., retired, former surgeon-general of the War Department, professor of preventive medicine.

Faculty of Columbian College.

Edwin A. Hill, A.B., M.A. (Yale), Ph.D. (Columbian), assistant professor of chemistry.

Thomas M. Price, B.S. (Md. Agricultural), Ph.D. (Columbian), assistant professor of chemistry.

Timothy W. Stanton, B.S., M.S. (Colorado), Ph.D. (Columbian), assistant professor of paleontology.

Philander Betts, B.S., M.S. (Rutgers), E.E. (Columbian), assistant professor of electrical engineering.

Paul N. Peck, A.B., A.M. (George Washington), instructor in mathematics.

Department of Medicine.

Arthur M. Tasker, B.A. (Wesleyan), assistant in chemistry.

Ernest W. Brown, Ph.D. (Yale), assistant in chemistry.

DR. ALEXANDER MCKENZIE, lecturer in the University of Birmingham, has been appointed head of the chemical department at the Birkbeck College in succession to Dr. John E. Mackenzie, who has become principal of the Technical Institute, Bombay.

APPOINTMENTS at King's College, London, have been made as follows: Mr. E. P. Harrison, Ph.D., and Mr. H. S. Allen, M.A., assistant lecturers in physics; Mr. C. F. Russell, B.A., assistant lecturer in mathematics; Mr. L. Hinkel, assistant demonstrator in chemistry; Mr. W. Woodland, demonstrator in zoology; Mr. O. S. Sinnatt, B.Sc., and Mr. R. Wolfenden, B.Sc., demonstrators in engineering; Mr. J. E. S. Frazer, F.R.C.S., demonstrator in anatomy.

DR. G. N. WOLDRICH has retired from the chair of geology in the Bohemian University at Prague, and is succeeded by Dr. Pocta.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, NOVEMBER 17, 1905.

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE FUNCTION OF THE STATE UNIVERSITY.[1]

THE UNIVERSITY OF ILLINOIS owes its foundation to the initiative of the federal government of the United States.

The celebrated Morrill Land Grant Act of July 2, 1862, provided that each state in the union should be granted thirty thousand acres of land for each senator and representative to which the state was entitled in the federal congress, for the establishment and support 'of at least one college, whose leading object shall be (without excluding other scientific and classical studies, and including military tactics) to teach such branches of learning as are related to agriculture and the mechanic arts, * * * in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life.'

This has turned out to be one of the most magnificent endowments of higher education ever made by any government, church or individual, whether we have regard to its immediate effects in leading to the establishment of the particular institutions contemplated in the act, or to its remoter effects in further increasing and stimulating state benevolence for this same general purpose.

As the result of the said grant, at least one institution corresponding to the above description has been established in each state and territory in the union. There

[1] Inaugural address of Dr. Edmund Janes James on the occasion of his installation as president of the University of Illinois, October 18, 1905.

are now more than forty-nine in all! The states have in nearly every instance contributed to the further endowment of these colleges in the form of permanent funds or what is practically the same thing, in the form of permanent annual appropriations, exceeding, and in some cases far exceeding, the amount given by the federal government itself.

In some instances the new college was incorporated in, or annexed to, some existing institution. In others it was made an entirely independent institution limited to instruction in agriculture and the mechanic arts. In still others it became the nucleus of a great state university, with all the departments properly belonging to an institution which may justly lay claim to that time-honored name.

This was the case in Illinois. The proceeds of the sale of this original land grant constitute an endowment fund providing about thirty-two thousand dollars a year for the support of the institution.

In 1887 the federal government passed an act known as the Hatch Act, providing an appropriation of fifteen thousand dollars a year, to each state in the union, for the establishment and support of an agricultural experiment station. This, in the state of Illinois, was made a department of the state university.

In 1890, by what is known as the second Morrill Act, the federal government appropriated an additional sum of fifteen thousand dollars a year, to be increased by one thousand dollars annually until it reached the sum of twenty-five thousand dollars a year, for the further endowment of colleges of agriculture and mechanic arts, founded on the act of 1862. This sum, in Illinois, was naturally also turned over to the state university, so that, by these various federal acts, the University of Illinois now receives, either directly or indirectly from the federal government, about seventy-three thousand dollars a year, to be applied in the maintenance of an agricultural experiment station, and the colleges of agriculture and mechanic arts.

The state of Illinois has added largely to this sum of seventy-three thousand dollars for the support of these two enterprises. The last legislature, for example, appropriated four hundred thousand dollars per annum for the support of these departments, or more than five times as much as the federal government. In addition it also appropriated considerable sums for the support of other departments which, although not mentioned specifically in the Land Grant Act of 1862, were contemplated by the words 'not excluding other scientific and classical subjects.'

In other words, the state of Illinois has not only applied conscientiously to the purposes of the federal act all the funds which the congress has provided, but it has actually appropriated five times as much for these same purposes as the federal government itself. In addition it has provided for the other departments necessary to transform the original college of agriculture and the mechanic arts into a full-fledged university of the modern type.

The comparatively small sum thus appropriated by the federal government has led in the sequel to the expenditure of ten times as much for higher education by the state of Illinois. The other states have followed in the same general path, so that it is doubtful whether a similar expenditure of funds to that made by the federal government on this occasion ever led to proportionately greater returns for higher education, in the history of any time or country.

The University of Illinois has become the largest of the institutions which owe their origin to this federal grant. Opened for

work on March 2, 1868, with fewer than one hundred students, its growth for the first twenty years was very slow, as the state at first declined to give very largely in addition to the federal grant. Indeed, it seemed inclined for a time to limit the institution strictly to the work of a college for agriculture and mechanic arts, in the narrowest sense, as was indicated by the name first selected for it, namely, 'Illinois Industrial University,' and by the refusal of the legislature to do more than apply in good faith the proceeds of the federal grant to its support.

But about the year 1887 a new spirit became manifest. The Hatch Act, furnishing additional funds for the support of scientific work in the domain of agriculture, seems to have been potent in stimulating this new attitude. As a result of the activity of the alumni and of other friends of higher education in the state, the legislature was prevailed upon to change the name to the 'University of Illinois.'

What is in a name? Sometimes much, and so it was here. Giving this name—the University of Illinois—to the institution, if not at that time an indication of a conscious change of purpose on the part of the people of this state, powerfully helped, at any rate, in working out this change of purpose and bringing it to the public consciousness.

It did not, of course, immediately produce large results, and even so late as 1890 the faculty of the school numbered only thirty-five, and the student body, four hundred and eighteen. Since that time, partly as a result of the impetus given by the second Morrill Act of 1890; partly as a result of the changed attitude on the part of the state toward the institution, evidenced, even though unconsciously, in this change of name; still more, perhaps, as a result of that marvelous increase of popular interest in higher education manifested throughout the country in the last fifteen years; the legislature of Illinois has become more and more liberal in its appropriations, enabling the institution to approximate with an ever-increasing rapidity toward the ideal expressed in its name, 'The University of the State of Illinois.'

The increase in the attendance and in the instructing body has been remarkable. The faculty has grown to number nearly four hundred and the total number of matriculants in all departments for the present year will probably reach four thousand.

This rapid increase has been partly the result of adding new colleges—in some cases existing colleges with an honorable history and a considerable attendance, as in the case of the colleges of medicine and dentistry—and partly the result of increased attendance in the older departments.

To the original colleges of agriculture and mechanic arts, contemplated in the first act (including engineering and architecture), have been added the colleges of liberal arts, of science, of law, of medicine and dentistry, and the schools of music, of library science, of pharmacy and of education.

In the college of liberal arts and the graduate school connected with it, are included the ordinary subjects of instruction embraced in the modern university so far as they are not included in the other schools and colleges mentioned, except those belonging to a theological school.

Associated with the university are, besides the agricultural experiment station already mentioned, the engineering experiment station (the first of the kind in the country); the state geological survey; the state laboratory of natural history; the

state entomologist's office and the state water survey.

Such is the university now. What is to be its future? At the risk of incurring the fate of a prophet I will undertake to forecast the future of this institution to a limited extent; and I do it with more confidence because the history of other state institutions has already indicated some of the things in store for us—institutions in whose footsteps we are sure to follow, and if at first *longo intervallo* yet with increasing determination to press them ever harder in all those things which pertain to a true university.

I take it first of all, then, that this institution is to be and to become in an ever truer sense, a university. That, I presume, has been settled once for all by the people of this state. It was settled, even though unconsciously, when the word 'industrial' was stricken out of the title, leaving it simply 'The University of Illinois'—by no means the first time that the subtraction of a word from an expression has indicated an addition to the meaning.

It has been settled anew at each successive session of the legislature, as by one increase after another in the appropriations the representatives of the people in the general assembly have set the seal of their approval on the large and wise policy of the trustees.

It has been settled by the ever-increasing purpose of the great mass of the people of this state, the plain people of the farm and the mill, of the country, the village and the city, to build here a monument which will be to them and their children an honor and a glory forever, an evidence which all the world can see and understand, of their corporate appreciation of the things of the spirit.

What then is a university—that which this institution is to be and become?

Men of different nations and different times would give different answers to this question. Nay, men of the same nation and of the same time would give different answers. In fact so different would be the answer given by different men in the United States at the present time to this question, that one might well wonder whether there is any common agreement as to what a university really is.

I must, therefore, answer this question for myself, for this time, and this place, and this institution without, however, reflecting in any way upon what other institutions bearing this name are or may become. I believe that the system of institutions which shall satisfy the educational demands of a nation like this must embrace higher institutions—universities if you will—of many different types. In sketching out the future of the University of Illinois, therefore, I do so with due regard to the fact that we have in this state important and valuable institutions of an entirely different type whose work the University of Illinois will thus supplement and complete.

I should define a university briefly as that institution of the community which affords the ultimate institutional training of the youth of the country for all the various callings for which an extensive scientific training, based upon adequate liberal preparation, is valuable and necessary. You will note the elements in this definition. By virtue of the function thus assigned to it, it is in a certain sense the highest educational institution of the community. It is the institution which furnishes a special, professional, technical training for some particular calling. This special, technical, professional training must, however, be scientific in character, and must be based upon adequate preliminary preparation of a liberal sort.

By this requirement of a liberal preparatory training, the university is differentiated from the technical school or trade school of secondary grade. By the scientific character of its training, it is differentiated from a mere preparatory 'cram' school for public examinations: such as were so many of our private professional schools down to a recent date.

There are certain things, then, which must mark this institution in order to make it a true university. The most striking peculiarity is the scientific character of the training which it affords. A consideration of this feature—for to my mind it is the fundamental and distinguishing quality of the university—may properly delay us for a moment. There are many ways in which a man may be prepared for a profession. He may have no school training whatever of a special or professional kind. Having acquired a knowledge of the elements of learning, he may be thrust directly into the practise of a profession in order to learn 'by doing.' This has been characteristic of most of our professional work in this country down to within a recent date. But even when schools have been organized to afford such training, they may still be of very different kinds. Thus they may be merely institutions to purvey what is already known in the profession, their purpose being to fill the minds of their pupils with knowledge of what at present is known about the subject in hand; perhaps to enable them to pass a state examination which may be prescribed in this particular field, or to pass a university examination set for the purpose of testing one's knowledge rather than one's power.

A school may, on the other hand, be organized on the theory that the best way to prepare a man for the practical duties of a profession, so far as it can be done in school, is to train him to be an independent investigator in the domain appropriate to the profession. Thus, from this point of view, the best way to prepare a man for a professorship in mathematics would be to train him in mathematics in such a way and to such a point that he might have a power of independent judgment in the domain of mathematical problems; that in an independent way he might discover the possible mathematical problems for himself and be equipped to handle them one after the other as he might have occasion or opportunity to take them up. In the same way the best training for a lawyer or a judge would be such a training in the science of the law as would enable him to have a power of independent judgment on any legal question he might meet, such as would qualify him to take up with entire freedom and with a feeling of ability the investigation of any topic which might come before him.

It is this latter idea which underlies the German university and the German professional school. According to the idea of the Germans the way to prepare a man to become a professional chemist is not to load him down with all the knowledge of chemistry which the world has thus far accumulated, though such an acquisition under certain circumstances may be valuable, but to train him in the field of chemistry in such a way as to make him an independent investigator—one who will be qualified to meet any chemical problem coming up in the course of chemical work. In the same way, to prepare a man to be a professor of history is not, according to the German idea, to fill him up with the knowledge of all historical facts, for such facts have already passed, in their multitude and magnitude, beyond the power of any man to grasp, even that of a von Ranke; but to give to the man a historic

sense, or at least to awaken it in him (for if he has it not it would be difficult to create it entirely anew), to develop his critical spirit, to qualify him to take up the investigation of any particular historic problem in such a way that when he has finished his investigation the last word will have been said, so far as the existing material will permit.

In addition to this, the purpose of the professional school should be not merely to qualify the student to do this kind of research, but to inspire him with an ambition actually to do this kind of work to the extent of his ability, whatever the position to which he should be called.

I do not know to what extent this peculiarity in the conception of a true professional school may explain the leadership which Germany enjoys to-day in the world of science and scholarship, that is to what extent this peculiarity in their educational system has produced this thirst for scholarship and learning, or to what extent their natural thirst for scholarship and learning has worked out this peculiar device for stimulating such a spirit. Whichever may be true, I think we must allow that in this particular quality the German university surpasses those of the rest of the world.

They carry this thought much further in Germany than in any other country. No man is allowed to teach, even in a secondary school of the first grade, who has not come under the influence of the theory and practise of this sort of a professional school. And while the German universities, judged from an American point of view, have many defects, this is certainly one of their strongest points, and one which, if we can in any way secure for ourselves, in our own institutions, would be a great advantage to us.

It goes without the saying that in such an institution as we are outlining the faculty will consist of men and women who will have developed this quality of scholarship, this idea of learning, this notion of productive work in the field of scientific investigation and research. It can not be anything else and accomplish the ends we have in view. Now, of course, there is a long road to travel between our present situation in this respect and that time when, judged from this point of view, we shall be a true university. I say a long road, but it will be covered, I fully believe, in a comparatively short time; for the idea of this advance has already permeated this body of instructors, has touched with its dynamic force every aspiring soul in the group and will in the long run leave no individual untouched, and will leave no person unaspiring.

What this spirit, if it could become general, would mean for our scientific advance as a nation, what it would mean for our industrial improvement, surpasses almost the power of the human mind to conceive. Suppose every one of our high school teachers in this country had had a university training in the sense in which I am using the term, so that when he goes into a community and begins his work of instruction there also goes into that community a new power, a new force, being itself first of all productive, and then aiming to select from that community the young minds which may have it in them to add to the power and resources, to the wealth, moral, intellectual and material, of their communities, and kindle in them the sacred flame of aspiration, as only the genuine fire of scientific enthusiasm can kindle it. Suppose every student who goes forth from this chemical laboratory should carry with him the power and the determination to add something to our knowledge of chemistry, what an addition to the industrial resources of this country! It would mean

more than the annexation of many fertile islands beyond the sea, and would cost far less.

In brief, then, this institution must become, in all departments of professional life, a great center of scientific research and investigation, and must become so, if for no other reason, because the professional training itself can not be of the highest type unless it be given by men who are qualified for, and eager of, scientific effort.

This university will include within itself not merely the old professions—law, medicine, teaching—but it will include scientific preparation for any department of our community life, for the successful prosecution of which an extensive scientific training of this kind is desirable or necessary. We shall add, therefore, from time to time schools or colleges which will take care of these new professions as they may appear. We have already begun with the profession of engineering in all its various forms—mechanical, civil, electrical, sanitary, chemical, etc., the profession of architecture and the profession of farming. The next to be entered upon in a large and satisfactory way is the profession of business. Some of these newer callings are, of course, quite different in their character, and will call for quite a different kind of training from that of the old so-called learned professions. It will hardly be possible to turn through the halls of our universities, even though they be multiplied many fold, all those who expect to enter in one capacity or another the great world of business. And for many a long day to come the great geniuses in this department will probably be men who have had no university training; for the 'wind bloweth where it listeth' and many a genius will sprout and bud and flower in this domain who has not seen even the outside walls of a preparatory school or college or university. But we have already reached the time when the subject matter relating to the world of business has a content which is susceptible of scientific treatment, the study of which, under proper conditions, may become a valuable element in the preparation for business. The time has come, therefore, when the college of commerce should be one of the constituent colleges of the university.

So I expect to see this institution increase the number and quality of its professional schools as the years go on, until it will have developed into a full-fledged university of the broadest scope, capable of answering to the multiform needs of a great commonwealth.

In a word, this institution will most fully perform its duty to the people of this state if it will stand simply, plainly, unequivocally and uncompromisingly for training for vocation, not training for leisure—not even for scholarship *per se*, except as scholarship is a necessary incident to all proper training of a higher sort for vocation, or may be a vocation itself, but training to perform an efficient service for society in and through some calling in which a man expresses himself and through which he works out some lasting good to society. Such training for vocation should naturally, and would inevitably, if the training were of the proper sort, result in the awakening of such ideals of service as would permeate, refine and elevate the character of the student. It would make him a scholar and investigator, a thinker, a patriot—an educated gentleman.

It is apparent to any one who knows the present condition of the university, and for that matter of any of our American universities, that such a conception as this calls for a continued growth at the top and a lopping off at the bottom. In other words, it requires an increasing standard

of admission to the university, and an extension of the scientific character and quality of the work done inside of the university. And this development I consider will be as inevitable as the ebb and flow of the tides. My own idea is that the university ought not to be engaged in secondary work at all; and by secondary work I mean work which is necessary as a preliminary preparation for the proper pursuit of special, professional, that is scientific, study. Consequently, our secondary schools, our high schools and our colleges will be expected to take more and more of the work which is done in the lower classes of the various departments of the university as at present constituted, until we shall have reached a point where every student coming into the university will have a suitable preliminary training to enable him to take up, with profit and advantage, university studies, in a university spirit and by university methods.

Every community in this country ought to furnish the possibility of securing this secondary training, as near as possible to the heart of the community itself. Certainly every town of fifty thousand inhabitants, and, perhaps, every town of twenty thousand in the United States—surely every county in this state—should be able, through the activity either of public agencies or of private beneficence, to offer the facilities for acquiring this secondary grade of education which is appropriate to the high school and the college. Surely it is true that the work done at present in the freshman and sophomore years at the University of Illinois, and for that matter in any of our American universities, may just as well be done, so far as the quality of the work is concerned, at any one of fifty or one hundred centers in the state of Illinois, as at Urbana; provided only that adequate provision be made for giving this instruction. And this adequate provision need not be very expensive. There comes a time, in the growth of attendance at any institution, when it reaches its maximum efficiency. I have no doubt myself that in another ten years, unless we should have some great economic backset, there will be ten thousand students in the state of Illinois, who will want the kind of work and the grade of work offered in the freshman and sophomore years of the University of Illinois. Now it is to my mind perfectly apparent that it would be undesirable to have ten thousand freshman and sophomores in the State University at Urbana. It would be far better to have them scattered over the state at fifty other institutions, provided we can get these institutions to take care of them properly, and then send those of them who may desire the more advanced work up to the university.

So then, the institution must be lopped off at the bottom and expand at the top in order to become that true university of the state of Illinois which will render the largest service to the people of this community. We have, in the development of our college of agriculture a very excellent illustration of how, with the growing standard of this state, an individual professional school will gradually change its entire character by the continued raising of its standards. Thus far, we have been practically accepting in the college of agriculture any young man who desires to avail himself of the advantages for instruction offered here, and who seemed to the faculty likely to be able to do the work, without reference to his formal preparation. At the present rate of growth, in another ten or fifteen years there will be five thousand young people in this state who will want to pursue these studies. It would not be possible or desirable to take care of these five

thousand people in the college of agriculture at Urbana. I expect to see secondary schools of agriculture established at different points in the state where those who wish technical work of secondary grade can secure it near home, and from these the best trained and the best fitted will be sent up to the college of agriculture at the University of Illinois for their advanced training.

One may ask, at what point will you cease to raise these standards of admission? I think the answer to that question is very simple, namely, when we shall have succeeded in requiring from the young men and women who enter the university that degree and kind of preliminary education which, from a pedagogical and a social point of view, best qualifies them for the beginning of special, *i. e.*, scientific, training.

You will see from the above sketch that I look upon the university as an institution for the training of men and women, not of boys and girls. The latter, I think, is distinctly the work of the high school and the college, and the sooner it can be relegated to them, the better for the young people themselves, for the schools and colleges, for the universities and for the community. I have no doubt myself that when our educational system is as fully developed as is our commerce and our manufacturing, we shall see this differentiation of function.

But this institution will be and become not only a university in general, but it will perforce be a particular kind of a university. It is and will remain a *state* university, and certain consequences for its future flow from this fact.

The first thought in this connection is one of limitation. As a state university in America, there are certain things which it can not undertake, at least within any period which is worth our while to prognosticate for it. The old traditional university of the middle ages and later times consisted primarily of the three faculties of law, medicine and theology. The philosophical faculty was later added and in a few instances still another faculty was added, making usually four and sometimes five in the typical university.

The theological faculty was thus from the beginning an essential part of the university. It was an element of the university idea. A university without the theological faculty can hardly be looked upon, from a theoretical or historical point of view, as a complete university. Certainly the vast majority of thinkers would say that the absence of a theological faculty is a serious defect in an institution which aims to be a complete university. From the standpoint of the church I have always felt that it was a great disadvantage for it to educate its priests or clergymen in theological seminaries isolated and monastic instead of in theological faculties forming part and parcel of a great university which is itself in many respects a microcosm and life in which prepares for the great life of the world outside.

But in this country, of course, the state university can not undertake to establish a theological faculty for a long time to come, if ever; in fact, not until there is a substantial agreement on the question of religious beliefs and practises, at least so far as fundamentals are concerned. This day is certainly far in the future, and until it comes, the state universities in this country will certainly not organize or support theological faculties.

But we have gone somewhat further in our actual practise than our theory of separation of church and state might call for and we have cut from our curriculum of studies all courses bearing upon religion, even upon the history of religion.

I can not help thinking myself, that this is a serious limitation both to the university and to the church, none the less real and serious, because under our circumstances it may be necessary as a condition of development of the highest usefulness of the state university.

Let us not make a mistake here, however. The cutting out of formal religious instruction from the curriculum does not mean that a state university is necessarily non-religious, or anti-religious. An institution is religious or the opposite chiefly because the community of which it is a part is religious or the opposite. The character of the state university, like that of all the other institutions of the country, will be determined fundamentally by the character of the people itself. How true this is in matters of religion may be seen by the actual facts concerning our state universities. Thus, all of you who have followed the work of the Young Men's Christian Association must have been struck by the fact that it has no more active and vigorous centers of life than those in our state universities, and the international secretary of the association stated some time ago that the largest, strongest and best organized college Christian Association in the world was to be found here among the students in the University of Illinois. Religion, the religious spirit, the reverent attitude and all which is bound up with what is best in religion is not something, of course, which can be shut up within the dry bones of statistical tables, and yet the figures collected by our young people who have been interested in this matter show that there is very little difference between the number of students who are members of the church, for instance, at our state universities and at the other great educational institutions of the country—which would seem to bear out my proposition that the fundamental fact is not after all the presence or absence of religious instruction, but rather the character of the community from which the members of the state university are drawn.

At the same time, any one who is a believer in the state university and its function can not help regretting the feeling which certainly has prevailed in certain circles in the past if not in the present, that the state university is in a certain way anti-religious in its atmosphere and its work; for we can not close our eyes to the fact that whatever you or I as individuals may think of religion and religious training, the great mass of the people of this nation are deeply concerned that their children should be brought under what they conceive to be proper religious influence early in life, and should remain so throughout the college and university years.

It is then a matter of congratulation to those of us who have seen in this opposition to the state universities a certain menace to their prosperity, that there are many signs that this particular difficulty is going to be met in what will be an extremely satisfactory way to all concerned. The great religious denominations have come to recognize that these institutions are destined to grow and increase with every passing year, and that the state of which they themselves are a part will never agree that the principle of the separation of church and state shall be infringed upon to the extent of providing religious instruction in state universities, and that therefore the duty is upon them to see that adequate provision is made for this great need. They are solving it in different ways. They are in some instances erecting guild houses and dormitories where the children from the families of their particular faith may find centers of influence and help. In other places they are providing lectureships upon religious subjects for the bene-

fit of any students who choose to attend. In some places they are beginning to imitate the Canadian system so well exemplified in the University of Toronto, of organizing local colleges with the specific purpose of offering instruction in religious topics and in other subjects which the state university may not adequately support for the benefit of students who desire to take such work.

For my own part, I believe some such device as this last named will be found to be a very satisfactory and helpful one, and that by this means we shall solve this problem, which is none the less real and serious because we have too often been inclined to close our eyes and ears to the facts and refuse to consider the question, imagining that if we could only bury our heads in the sand we should be free from the necessity of meeting it and grappling with it. When we can combine the freedom of the state university with the opportunity for instruction in religious matters which the great mass of our people holds to be desirable and necessary to true education, we shall have taken a long step toward solving not only this particular problem, but many others which touch it and ramify from it in many different directions.

But if the first thought growing out of the fact that this is to be a state university is one of limitation, the second and prevailing thought is one of freedom, of privilege, of ease of movement, of facility, of adaptation.

No one will certainly accuse me of underestimating the work or importance of the non-state university. I owe my own education entirely, after leaving the public high school, to the non-state school, particularly to the denominational, if not sectarian, school, and my own work as professor and president has been, until I came here, entirely in connection with such schools. Northwestern, Harvard, Pennsylvania, which though in name a state, is in fact a private institution, and Chicago represents the course of my student and professional life. No one, I believe, can entertain a deeper feeling of gratitude to these institutions and to the men who have founded and built them up, than I. No one can have a higher appreciation of the value of their services to the community than I, and I may say that the more I learned about each of them, the more I was impressed with the magnitude of their service to the community.

The University of Chicago, for example, has not only done the ordinary service which any well equipped institution of higher learning does, but it has played a most important part in advancing the standards and educating public sentiment on higher education throughout the Mississippi Valley. It is not too much to say that every institution of college or university grade in the middle west has profited directly or indirectly by the magnificent work of this institution—and by no means the least among them, the University of Illinois. It may not be out of place for me to say that the University of Chicago has been in large part, from this point of view, William R. Harper, whose absence we so much regret on this occasion. If Chicago University had done nothing else in the last fifteen years than provide an opportunity for the blessing-bringing activity of William Rainey Harper it would still be worth to the community all it has cost.

But even if I owed no personal debt or obligation to these institutions, if I had never for an hour enjoyed the benefit of instruction within their halls or from any one who came from them as teacher, still I should certainly be a blind, ignorant guide indeed if I should by any remark of mine belittle these institutions or derogate in any way from the glory which properly belongs to them. We believers in

state universities, whatever we may think of the future, must certainly acknowledge that we owe everything that we have been, and almost everything that we are, to these non-state institutions. If the history of American education were to be closed to-day, certainly the chapter devoted to the work of the state university would be very short and unimportant, indeed, as compared with that which should relate the history and services of the non-state institutions—Harvard, Yale, Brown, Columbia, Princeton, Leland Stanford, Dartmouth, Oberlin, Johns Hopkins and the hundred others—what a galaxy! and how proud we all are of them and their work! No thoughtful man, it seems to me, however much he may desire that our state university should wax, would like to see these non-state institutions wane, and I believe we should all feel that anything which would injure the efficiency or the work of any one of these institutions would be a calamity pure and simple.

In my own view, Northwestern, the Armour Institute of Technology, the University of Chicago, Milliken University, and the score and more of other non-state institutions engaged in the educational work of this state, are a vital, fundamental and essential part of the life of this community. I can not, of course, foresee how many of the numerous small colleges in this state are destined to survive. Some of them, perhaps, may disappear. Others, I believe, will be newly founded. All of them, and more too, will be needed when the population of this state shall be ten millions, as it will be before many years. But even for the present I can not help feeling that any means by which such institutions as Lake Forest, Knox College and the Wesleyan and McKendree and Illinois and Shurtleff and St. Ignatius and a dozen others can be enabled to do their work in a thorough and efficient manner, will be a cause for congratulation to every lover of education. We are all part of the same enterprise, engaged in working out the educational problems of this great commonwealth, and that enterprise is going to be the greater and the more glorious in proportion as each of us is enabled to do fully and faithfully his part and portion in the work.

I am a great believer in the desirability, nay, from certain points of view, the necessity, of a complete scheme of state education from the kindergarten through the professional school. I believe the state owes it to itself, to its own people, to the nation, to provide such a scheme of education.

But I have never felt that the system of state education should be monopolistic in character, should be exclusive, *i. e.*, should try to cover the entire territory and the entire field to the exclusion of church or private agencies. The extent to which the private institution has been driven out of the field in Germany and France has been and is a serious intellectual, material and spiritual loss to both these countries. On the other hand, the extent to which higher education has been left entirely to private hands in England has been equally serious and damaging to the interests of that country. The extent to which we have brought about a cooperation between the principle of public and private initiative in the field of higher education is a striking illustration of our good fortune, if not of our insight—for after all it has been largely accidental. It is desirable that the state of Illinois should have a state university, no matter what the church or private individuals may do, no matter how many institutions these may build up by its side. It would be equally *un*desirable if the state of Illinois should attempt by either direct

or indirect coercion to drive everybody desiring higher education into the state university. Northwestern University, and Chicago University, and the Armour Institute of Technology, and Milliken University and the many small colleges in the state are taking care of students of college and university age, in the aggregate far in excess of the number provided for in the state university. And in my opinion they always will, and, further, they always should.

In other words, while I am a firm believer in the principle of a state system of education from the lowest grade to the highest, I believe also thoroughly in utilizing, as far as possible, the assistance of all other agencies in the same department of education. And this cooperation will, in this country, for aught that we can see, for an indefinite period be not only desirable, but necessary to meet our educational needs.

It is the non-state institution then in England and in this country which has been in a certain sense the 'ark of the covenant,' which has carried on from generation to generation the precious deposit of learning and has been the intermediary by which the spiritual possessions of the past have been carried over and made the possessions of the present.

Endowed institutions, whether under private or church control, have thus done a vast service. But, on the other hand, they have the defects of their virtues. Educational institutions, whether private or state, are by nature conservative. They resist changes and improvements. They fight progress almost as by a law of their being, and the greater their endowments, the more completely they are removed from the necessity of appeal to the life of their own generation for support, the more set do they become in their conservatism, the more bulwarked in their opposition to all progress. They may by their wealth defy the currents of progress. They may oppose themselves to all forward movements. Not only may they do so, but in nearly every instance in history they have done so. The history of every European country demonstrates that these bodies, the universities and colleges, have had to be reformed by law. Left to themselves they have suffered of dry rot in an extreme form. Oxford and Cambridge fought bitterly all attempts to force them into line with modern progress. It was the forcible subjection of the German university to the directing power of the government which broke up the crust of conservatism and paved the way for that wonderful career of progress which put Germany at the head of scientific progress. Even in our own country our colleges and universities have the same opposition to education and progress to record. If the people in this country had handed over to college and university faculties the decision of the important educational questions which they have had to settle in the last fifty years, we should have to-day practically no high school system, or one of comparatively little value. We should have no system of state universities. We should have, to a large extent, no professional schools of high quality at all. It is, indeed, a question whether we should have even an efficient free common school system.

Fortunately for us, however, our institutions as a whole have been so poverty-stricken that they have been compelled to appeal to the community continually for funds, and in doing so they have been forced into lines of progress which have become more and more evident in the past few years. I am a great admirer of Harvard University, easily the greatest of our universities; I am a great admirer of Harvard professors, and especially of that

great man, the present president, *facile princeps* among the leaders in American education of the last twenty-five years, Charles W. Eliot, but I do not believe there has ever been a time, down to within a very recent date, when, if the faculties of Harvard College could have had absolutely their own way, and had had money enough to persist in their own way, they would not have committed themselves squarely against every question of educational progress which the scope of the times has brought to them. And what is true of Harvard is still truer of the less progressive institutions of higher learning, of which we have many.

So I believe it is necessary, friends, by the side of this system of private, endowed, church institutions, to maintain a system of state institutions. By the side of these other great institutions of learning it is necessary in this country to maintain the state university, which, because of its entirely different origin, because of the different influences to which it is subject, can work out a supplemental scheme of education in many different directions, extending into many fields which would be neglected in all probability by these other institutions. Such an institution, even though not a leader by choice, will by its very constitution be compelled to adjust itself to modern demands and thus force the other institutions which wish to exist by its side into a larger and more liberal view, and finally into what is clearly the line of progress.

The state university is necessary in order to help maintain the democracy of education; to help keep education progressive; and finally in order to keep higher education close to the people, and make it the expression and outgrowth of their needs.

As a *state* university, we may properly demand from this institution that it undertake certain functions which it is not so easy for other institutions to assume.

This institution as a state university may become more directly and immediately the external expression of the corporate longing of the people for higher things in the sphere of education than can any other type of institution. This is said with all due regard for and due recognition of the real way in which the private institution has entered into, and is a real expression of, the life of our people. Fortunately, we have never needed to fear, in this country, what some of the continental nations seem to have feared, namely, that institutions of learning under private or church auspices would work against the public interest of the community of which they are a part. The fundamental object of all institutions of higher learning may be summed up from one side, as the creation of the highest and most efficient type of citizen. And fortunate it is for us that we may truly say to-day, as in all previous periods of our national history, that all our higher institutions of learning, whether founded by private individuals or by religious sects, have in this respect worked out the same beneficent result for the community; that the graduates of all these schools alike have been to the same extent good citizens, have been devoted patriots, have been self-sacrificing and public-spirited members of society.

And yet I can not help but think that an institution, in the establishment and endowment of which every citizen feels that he has a direct and immediate share, expresses in a certain way more fully his desire for higher things in the field of education than can any other type of institution.

As the citizens by their combined effort make it possible to raise the standard, enlarge the outlook and increase the equip-

ment of such an institution, they are by this very act themselves widened in their own outlook, enlarged in their own sympathies, quickened in their own higher life. And as this institution is thus made more efficient, it again in turn reacts upon the quality of its clientele and its constituency by turning back into its midst an ever-swelling number of young people, who in their turn by their higher education and their more efficient training raise the level of the society from which the institution springs. And so there is a real moral influence, and a real moral power proceeding from this relationship between the state university and the citizen, which is none the less real, none the less effective because, like all spiritual things, it is impalpable, and, to a certain extent, elusive. And just as the creation of the public elementary school opened a new era in the consciousness of the American people as to its duties toward education, just as the creation of the public high school has opened a new outlook, established a new consciousness on a higher plane of the duties of the community as a whole in the field of secondary education, so the creation of the state university has marked a new, a forward, an upward step of no mean importance and no mean power. It is a great step to get a whole people to recognize in its corporate capacity that one of its fundamental duties is higher education, and that one of its fundamental purposes should be the creation of organs of activity which should realize and carry out this fundamental function. It means that the whole people has passed on into a new and a higher state. It is no longer an appeal to a man as a Christian that he should look out for the education of the community of which he is a part, and to which he owes a duty—surely a high appeal—it is no longer an appeal to the Baptist or the Methodist or the Presbyterian that he owes it to the church and that the church owes it to itself to look out and provide for the existence of church institutions of higher education—surely a high appeal—nor is it merely an appeal to him as a philanthropist, striving as an individual to return to society some part of the wealth he has achieved; but it is a far more fundamental, a far more universal appeal to him in his capacity as a member of society, whether Catholic or Protestant, whether Baptist or Presbyterian, whether rich or poor, that this duty to assist higher education is as complete and all embracing and fundamental as any other duty of citizenship. There is no doubt that when a community reaches this point of view it has passed onward and upward into a new and a higher state of educational consciousness with an ever wider educational outlook, and with the promise of undreamed of visions in the years to come.

It is a necessary part of the idea of a *state* university that it shall be an organic member of the state system of public education, and that while, therefore, in a certain sense it is the crown of this system, it must rest solidly and securely upon a sound basis of secondary and elementary training. No state university can become the most efficient instrumentality for educational work within its jurisdiction unless it is built up upon a sound system of elementary and secondary schools from the kindergarten to the university itself.

It follows from this that the university must itself be an active organ in developing, if necessary in creating, in refining, in elevating, the character of this elementary work; for without it the university can not become a true university at all.

It follows, moreover, that the university must be most intimately and continuously associated with the scheme of elementary

and secondary education. It must be so immediately based upon it that there shall be no gap between the university and this scheme of preparatory work.

From this, several consequences follow, some of them beneficial and some of them, if not injurious, at least antagonistic in a certain sense to the highest and most rapid development of the university.

The state university can not require for admission what the secondary schools of the state can not give, and if these remain few in number, and of a low type, the university itself must be content with living upon a lower plane of usefulness than would otherwise be the case.

It is a natural outgrowth, therefore, of this essential fact that the state universities were the first of the higher institutions to get into close organic touch with the great element of the secondary system, known as the public high school, and that they have worked beneficently upon this system of lower schools, sustaining, lifting and improving it.

It follows, also, from this that the state universities were the first to find it necessary to adapt their own requirements of admission, to adapt to some extent their own curriculum, to the needs of these secondary schools which have a much wider function than that of simply preparing for the university. And so the state university has been determined in its educational policy by the needs of the secondary school itself, thus bringing about a most intimate relation. The result of this intimate relation between the state university and the secondary schools has been that the university in all the states where it has been put upon the proper basis, has been the most active and energetic influence urging the community to develop in an adequate way the secondary school system.

The statement is sometimes made by opponents of large appropriations to the state university that you had better spend more money on your lower schools, and less on your higher, if you desire to improve the educational quality of the public school system. No graver mistake could be made than that which is involved in the ordinary understanding of this proposition.

You can not have good kindergartens unless you have good primary schools. You can not have good primary schools unless you have good intermediate schools. You can not have good intermediate schools unless you have good high schools. You can not have good high schools unless you have good universities. In other words, no community reaches the upper grade of efficiency in its elementary schools, except by establishing and improving the quality of its higher schools. This is so apparent to a student of education, and seemingly so difficult of comprehension by the general public, that a further word may not be out of place.

Suppose a state had ten millions of dollars to spend on its school system. My proposition is that a considerable portion of that should be spent upon the highest grade of the system, the university, in order to secure the effective expenditure of the money in the lower grades, and that if you were to spend ten millions of dollars upon your primary schools and nothing upon your higher schools, you would have a far inferior system of schools to what you would have if you provided for an adequate scheme of higher institutions.

Certainly you can not have good schools unless you have good teachers, and all our experience shows that you can not have good teachers in any grade of schools unless you have good schools of a higher grade where these teachers may secure their preparation. Moreover, there is a subtle moral force ever at work in school

matters which makes it impossible to secure the highest point of efficiency in any grade of the school system unless it looks forward to and prepares for something higher. You can not have good schools of an elementary grade unless there is the opportunity for your best pupils, for those who have the time and money, to pass on up to ever higher grades of study. This is the justification of the high school, the college and the university from the standpoint of the eighth and seventh and sixth and first grade of the elementary school.

As a *state* university this institution will have intimate relations not merely with the high schools and elementary schools of the educational system, but with the other great element of the secondary scheme, namely, the normal schools.

Many people have thought that the normal school is in a certain way merely a temporary element in our educational system. It is intended to train teachers for the elementary and secondary schools. And there is a feeling in many quarters that as our high schools improve in quality and our universities multiply, the necessity of our normal schools will disappear.

I have no doubt myself that the normal school will change profoundly its character in the course of years, though how it will change I do not profess to know; but that it will, within any time for which it is worth our while to plan, become a superfluous element in our scheme of education I do not believe at all. Develop our universities as much as we may be able, develop our colleges as much as private enterprise and church initiative may assist us in doing, we shall still not be able to secure for our elementary and secondary schools an adequate number of properly trained men and women without the assistance of these normal schools.

I believe that they should stand in the very closest relation to the state university, and I believe that it should be possible to organize their work in such a way that persons who intend to prepare for the work of teacher in the elementary and secondary schools of the state, and for the position of superintendent and other similar administrative positions, should find it possible to pass either through the normal school and then through the university, or through the university and then through the normal school, as they may find it most convenient. I believe that all our universities would find it to their advantage to get into touch with this great normal school system, but for the state university this is an absolute essential.

The state of Illinois has established five great normal schools and has equipped them in a most liberal way, and will continue with increasing liberality to keep them fully abreast of the times. They are doing a work which no other element in our school system is doing, and I expect, for my part, to see them improve and grow rather than decrease, and the state university and the normal school together will form, if you please, a single institution for furnishing, in the most efficient and economic method practicable, properly trained men and women for the great system of public schools supported by the state.

But the state university, it seems to me, must proceed further than I have thus far indicated, and with one or two brief suggestions as to some of the directions in which the state university will develop, I shall bring these considerations to a close.

The state university will become more and more a great civil service academy, preparing the young men and women of the state for the civil service of the state, the county, the municipality and the township, exactly as the military and naval

academies are preparing young men for the military service of the government.

The business of the government is becoming more and more complex with every passing year. The American people is beginning to take a new attitude upon the subject of its civil service. Formerly it was thought that anybody who could read and write was fit for almost any position in the service of the state, and for a long time in the history of the country it was thought that the most practical method of selecting men and women for positions in the civil service was by their affiliation with and devotion to political parties or political factions. We are coming to a recognition of a new state. The abuses of politics have led the American people to the general acceptance of a principle, very far from being worked out as yet, under which men and women shall be selected for the civil service by a method which shall eliminate the element of political affiliation (I am speaking now of the administrative positions in the narrow sense of that term), and every passing year sees some new strengthening of this principle of the so-called merit system under which people are selected for posts in the public service on other grounds than that of party devotion.

But we shall not be satisfied very long with this condition of things. Public administration is becoming with every passing year a more complex subject. It calls for special knowledge. It calls for the trained mind and the trained hand. It will not be long, therefore, until the American people will, for many positions now practically open, insist that the holder shall be properly trained and qualified to perform the duties of that particular office; and now that the state offers every opportunity to secure an education not merely in the elements of learning, but in the secondary and higher grades as well; now that the state offers an opportunity to procure practically free the technical training necessary to qualify people for these posts, we may expect to see more and more a standard of efficiency set up and insisted upon by the people of this state, for all persons entering the public service. In an age of excellent courses in civil engineering supported by the state almost free of charge, we may expect to see the state require that the civil service aspirant in the field of surveying, for example, shall be a man of scientific training, not merely one who has learned his business by mere rule of thumb. We shall expect to see every municipality demand and employ men of careful scientific training to test its water supply and its food supply. In other words, the time of the haphazard, happy-go-lucky, hit or miss public official and of the ignoramus in the department of public administration is passing away in favor of the scientifically trained man who knows his business. Now the people of this state have a right to demand of the state university that it shall turn out men and women properly equipped for this kind of work, and who will return to the state in efficient service a thousandfold over, the cost of their trainng.

Now, all this you will note is in addition to and quite apart from the function of the state university as a center for the training of men and women who wish to enter the learned professions, a topic which has been discussed previously. To my mind, if the state requires an examination of proficiency from anybody as a condition of practising any profession, it should itself provide the centers properly equipped, where the requisite training may be obtained. And as the state may undoubtedly increase this supervision over callings now left free, we may expect to see the state, in the state university, provide opportunities for study in many directions which are not now to be found at all.

But the state university must be and become more than a civil service academy. It is and is destined to become to an ever-increasing extent the scientific arm of the state government, just as the governor and his assistant officers are the executive arm and the judges and the courts are the judicial arm.

As the business of government becomes more complex, the problems which the state has to solve in many different directions become more difficult, requiring in many cases most careful scientific experimentation and long-continued investigation, for the pursuit of which there must be adequate laboratory equipment and trained investigators. For all such work the state university is the natural and simple means already provided.

I have called attention to the fact that here in the University of Illinois are already located, for example, the state water survey, the state natural history survey, the state entomologist's office, the state geological survey, etc. There is no doubt that if the university is properly organized to undertake this scientific work in a way to make it thoroughly effective, it will, to an increasing extent, be constituted the scientific arm and scientific head, if you please, of the state administration.

It goes without the saying that this concentration of the scientific work of the state government at the university has most valuable educational results. The increasing number of scientific men centered at the universities helps create that scientific atmosphere, that scientific spirit which is absolutely essential to the upbuilding of a great university. This union of scientific investigation and educational work is a most fortunate combination for both sides of the enterprise. The scientific work for the state government offers an opportunity to train the young men in actual practise, and by thus securing their interest in and training for such work the government is able to obtain an ample and regular supply of properly trained workers in this field. By such a union the state secures the maximum of service at a minimum of cost.

Further, the state university will, I believe, in combination with the normal schools become practically, for many concrete purposes, the state department of education. We have already in this state and in most of the American states a state department of education, consisting usually of an officer called the state superintendent of public instruction. His duties, however, are comparatively narrow, as prescribed by law. The possibility of performing them is determined by very meager appropriations. Usually speaking, it is an office entrusted with the enforcement of the school laws and the distribution of the school money. The functions of the public ministry of education such as one finds in so many of the European states either are entrusted to him in a very small degree, or he is enabled to carry out these functions only within very narrow limits. The duty of canvassing the educational needs of the state from time to time, urging and impressing them in a strong way upon the people of the state, not merely upon the teachers and the legislatures and the government, but upon the great masses of the people—this is something which our American departments of education have done only to a very slight extent. Now and then a strong personality in the position of state superintendent has worked out great things for the education of the state. We have an example of such a personality in the superintendent's office of the state at present. But there is need of a more continuous, of a wider spread, of a more deeply rooted, activity in this direction, than the state superintendent's office under existing conditions can develop. Such a

function, within certain limits, I believe the state university combined with the normal schools can perform. The department of education in the state university organizing the resources of the state university for this particular purpose may bring to bear upon the educational problems and upon the educational needs of the state, an expert opinion which it is not possible to find in any other department of the state administration.

This function, it may be said, is not performed by the university in its capacity as a civil service academy, preparing teachers for the educational service of the state. It is larger and wider than this. It is a recognition of the university as one of the organs created by the state for determining, within certain limits, the policy of the state in the great field of education.

And thus I might proceed with a summary of other great things that are waiting for the state university if it only knows the day of its visitation; if it only measures itself up to its opportunities; if it only performs faithfully and simply the duties which the state thrusts upon it.

But time presses and I must draw these considerations to a close. I have left untouched many things you may have expected me to discuss, not because I do not consider them as important, but either because I regard them as so fundamental that we should all agree upon them or because the limitation of time does not permit even their mention. You will have gathered from what I have said my conception in general of the function and future of the state university.

It may be defined in brief as supplementary to the great system of higher education which private beneficence and church activity have reared, and it is to be hoped will continue to rear. It is corrective rather than directive; it is cooperative rather than monopolistic; it is adapted for leadership in certain departments, but must look to the non-state institution for leadership in others. It should be as universal as the American democracy—as broad, as liberal, as sympathetic, as comprehensive—ready to take up into itself all the educational forces of the state, giving recognition for good work wherever done, and unifying, tying together all the multiform strands of educational activity into one great cable whose future strength no man may measure.

Edmund Janes James.
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SCIENTIFIC BOOKS.

Structural and Field Geology, for Students in Pure and Applied Science. By James Geikie, LL.D., D.C.L., F.R.S., etc., Murchison Professor of Geology and Mineralogy in the University of Edinburgh, formerly of H. M. Geological Survey, author of 'The Great Ice Age,' 'Prehistoric Europe,' 'Earth Sculpture,' etc. New York, D. Van Nostrand Company. 1905.

This is a well-made and attractive volume of just the maximum size which long experience has shown to be the largest permissible for a handbook. It is of exactly the same dimensions as the first volume of Chamberlin and Salisbury, and although by the choice of a thinner paper the American book numbers two hundred more pages, it contains so many more figures that the text of the two is of about the same length.

Although the two books take opposite points of view, the one describing structures with little explanation, the other discussing processes with brief illustration, it is interesting to compare them. The Scotch book is as conservative as Edinburgh, the American as radical as Chicago. The former proceeds along the ancient ways with a leisurely fullness that is very attractive to a veteran, and recalls the time when he devoured Jukes or Nauman. The rock-forming minerals are described in detail, and the rocks with even greater fullness. The word petrography, with

all its synonyms, is omitted with much of the complex nomenclature and special doctrines of this new and aspiring science, while the American authors present a grand chapter on the 'Origin and Descent of Rocks,' starting with a molten magma (but discrediting a molten globe), and presenting the new quantitative classification of Iddings and Washington.

Fossils are next treated with great brevity in an excellent chapter of twelve pages. Much is omitted here that appears in Pennell, Cole and Keilhack and might have been expected in a manual of field geology. The book is rather planned for an advanced course in geology in Scotland with some field work, and it is interesting to note the classes for which it is intended according to the enumeration in the preface, viz., mining engineers, civil engineers, architects, agriculturists and public health officers.

There follow chapters written with great fullness and clearness upon the main geological structures, stratification, concretions, folding, joints and faults, the structure of eruptive rocks, and ore formations. The book is here at its best. The illustrations are abundant, well chosen and clear and the plan of printing many of the important figures as separate plates is used with especially good effect and several of the landscapes combine the highest artistic beauty with the greatest illustrative value. Several companion plates are very effective, for instance the field data of a complex area are presented on one plate and the completed map on an opposite plate. Again the tracings of thrust planes are given on a photograph of a mountainside and a section of the intricate geology of the mountain is given on a plate facing the first.

The chapter on metamorphism is brief. The Archæan is dismissed with a half page, and the line of treatment is not greatly influenced by the remarkable attempts to apply the laws of physical chemistry to the problem made by Van Hise, Grubenmann and Becke.

Then follows a chapter of fifty-four pages on geological surveying, which, as it is largely given up to the description of structural features, and, indeed, contains the only discussion of the glacial formation, offers only rather brief and general directions for field work.

The economic aspects of geological structure are then taken up in a very detailed and interesting way, full of practical suggestions for the application of the ideas developed in the preceding chapters.

The book closes with a brief chapter of thirty pages covering the whole subject of denudation and the evolution of all the surface features of the earth, and there is no suggestion of the survey or special field study of these subjects. The contrast between the two books comes out strongly here. The American book devotes 355 pages to the work on air and water and 38 to structural geology. The other gives 30 pages to erosion and 166 to structure. The author shows a great and, in the main, wise conservatism in the employment of new terms. Peneplain does not appear, nor any of the superabundant and largely anthropomorphic terms used especially in America in the description of topographic forms and the cycle of their growth. At the same time he gives with brevity a clear description of the river cycle. The author is, perhaps, not quite consistent as he uses the new or rare word 'phacoids' for 'augen,' which is fully as bad as phenocryst. He seems to wish here to avoid the German, but in another connection uses lee-seite and stoss-seite, when lee-side and stoss-side are good English. In still another connection the word hornfelses has an unattractive look.

In this large book, given up almost entirely to the presentation of facts, the reviewer has wished to criticize only one minor statement. It is said (p. 51) "Tachylite is altered to a yellowish or reddish substance known as Palagonite." Palagonite is certainly an original volcanic glass which has cooled with its present large content of water. A certain uncertainty inherent in the subject may be noted in the treatment of amphibolite and hornblende schist. The two volumes thus supplement each other in a valuable way, the one being a full and well-considered hand-book for use in the sober work of geological surveying or economic investigation, in a country like Scotland, where there are no active volcanoes,

earthquakes or glaciers; the other a bold and stimulating guide in every branch of research concerning the evolution of the earth.

B. K. EMERSON.

AMHERST, MASS.

The Students' Laboratory Manual of Physical Geography. By ALBERT PERRY BRIGHAM. New York, Appleton. 1904.

This is an expansion of the 'Teachers' Guide and Laboratory Exercises' published in 1903, and like it designed to accompany Gilbert and Brigham's 'Introduction to Physical Geography,' to which it is very closely adjusted. It is about half as large again as the 'Teachers' Guide,' but omits the lists of books. It is purely for the student and implies the additional use of the guide by the instructor.

Any one using the text referred to will find this an admirable guide for its illustration by map and exercise. It contains many suggestive questions that must help the inexperienced teacher toward modern points of view. This is particularly true of the questions on map reading, which are good and abundant, as they ought to be. For class use they may need some selection apart from selection of exercises, if thorough work by the student himself is to be done. Thus the exercise numbered 13, contoured maps, has material for three one hour exercises with pupils in the 'early stages of the high-school course,' if the reviewer's experience is to be trusted. Drawing a section for the first time, for instance, is no side issue, but quite a task in itself. Alongside this exercise 263b, C. S. Chart No. 3,089 is wonderfully short and easy, though for students well advanced toward the end of their course. The practical exercises are still further from definite form. It would be a hardship to put this book into the hands of the ordinary teacher of the subject, who is almost invariably too crowded for time and too incompetent in the subject matter to rearrange the exercises in practical form, and require her to use it with her classes. No doubt the class would get advantage of it.

It might be supposed that the wide use of laboratory manuals for physics and chemistry might guide us in some measure in preparing one for physical geography. Many of these are models in their clear statement of what materials to use, what to do with them and how to do it. This definiteness is of great importance. First-year pupils in a high school will find the latitude exercise in this volume, with its generalities, its principle, its geometry and trigonometry, very discouraging.

The description of field exercises for use in unknown localities has generality and vagueness imposed on it by necessity. It is difficult to conceive of satisfactory accounts being written for such work. Professor Brigham has gathered together some excellent suggestions, and that is all that can be done. The variety of the local fields forbids adequate general treatment. The point of view of the work is modern and scientific, as would be expected of its author. Teachers will find it a safe guide to open their eyes and those of their pupils to the real world about them. Altogether we are left still awaiting an adequate laboratory manual for physical geography, but in the present volume is much material that ought to figure in the book when it is written, much material that ought to be in the hands of teachers attempting laboratory work or wishing to know how to do it.

MARK S. W. JEFFERSON.

YPSILANTI, MICH.,
September 19, 1905.

Elements of Applied Microscopy. A Text-book for Beginners. By CHARLES-EDWARD AMORY WINSLOW, Instructor in Industrial Microscopy and Sanitary Biology in the Massachusetts Institute of Technology. Pp. 183, with 60 text figures. New York, John Wiley and Sons. 1905.

This manual is an excellent example of a book prepared for a definite purpose and as the result of experience in an institution where independent work and special ideas have a prominent place.

As the author states in his preface the book does not profess to compete, on the one hand, with monographs or on the other with the popular works on microscopy. It is, however, specifically intended for the class in industrial

microscopy for second year students in chemistry and biology at the Massachusetts Institute of Technology. The object of the course is to give facility in the manipulation of the microscope and an acquaintance with the scope of its practical application.

The first four chapters consider the microscope and its accessories, and the other eight chapters deal with the starches, adulterations of food and drugs, textile fibers, paper, medicine and sanitation, forensic microscopy, microchemistry, petrology and metallurgy.

Each subject is dealt with in a general manner to give the student the principles and the point of view. Exercises are then given to illustrate the methods necessary for the elucidation of the questions which arise in actual practise.

The book is well conceived and satisfactorily worked out. The statements are usually clear and concise. As planned by the author, it is an introduction to the subject, and was designed for use by a teacher possessing knowledge of the more elaborate books, and the monographs bearing upon the various subjects. For the student, excellent references to good sources for further information are given with each chapter so that those especially interested can follow out the subject.

It is not particularly adapted for private learners, as the directions are frequently too brief without the supplementary instruction which naturally goes with a laboratory course. Two directions would prove unsatisfactory in practise: On page 41 the student is told to transfer cover-glasses from the potassium dichromate, sulfuric acid cleaning mixture to fifty per cent. alcohol. *After a thorough rinsing in clean water,* should have been added. On page 28 under the directions for using the Abbe condenser, it is said: 'In general an opening [of the diaphragm] about the size of the front lens of the objective will yield good results.' While this applies to lighting, when no condenser is used it would lead one to light with a less aperture when using an oil immersion objective than when using a low power dry objective. It contravenes the principles given in the preceding chapter. These and a few other slips will be easily remedied by the teacher and will be naturally righted in a new edition.

It is a source for congratulation that books of this kind are originating from the laboratories of our country, and it is hoped that the number will increase. S. H. G.

The Structure and Development of Mosses and Ferns (Archegoniates). By DOUGLAS HOUGHTON CAMPBELL, Ph.D., Professor of Botany in the Leland Stanford Junior University. New York, The Macmillan Company; London, Macmillan & Co., Ltd. 1905. All rights reserved. Pp. vii + 657. 8vo.

It is but a little more than ten years since the first edition of this book appeared, and now we have a second and considerably revised edition, in which much new matter has been added. By an odd oversight, the fact that this is a second edition is not indicated on the title page, although it is clearly stated in the 'Preface to the Second Edition' with which the volume opens. In this revision, the whole book has been printed from new type, none of the old stereotype plates having been used. This has given the author as much freedom in the preparation of the present book as though it were wholly new, and he has not been obliged to confine his changes to such as could be made to conform to the limitations of the old plates. The result is that this is a new book, and while it resembles the earlier one, and contains much matter which was in that edition, there is scarcely a page or paragraph in which the author has not made some changes of greater or less importance.

The new book follows the same general sequence as the old one, and, on a cursory glance, the reader sees little difference, yet a closer examination shows many changes and additions. The more important changes are those in the treatment of *Marattiales, Isoetaceae* and *Lycopodinae.* In the old edition, the *Isoetaceae* were discussed in connection with the *Marattiales,* to which they were regarded as related, but in the new book we find them taken up after the *Lycopodinae,* being regarded as 'sufficiently distinct to warrant the establishment of a separate order, *Isoetales.*'

Two wholly new chapters have been added, viz., the 'Nature of the Alternation of Generations,' and 'Fossil Archegoniates.' The whole number of pages in the earlier book is 544, while in the present volume it is 657. So, too, there are 266 figures in the old book, and 322 in the new. The amount of enlargement of the bibliography may be estimated from the fact that it covers 13 pages in the first edition, and more than 23 in the second.

In his closing chapter, the author presents a revision of the summary and conclusions of his earlier book. Briefly, he now holds that the archegoniate series began in the green Algae near *Coleochaete;* that the Liverworts are the most primitive of existing archegoniates, and that other groups have descended from them. The peculiar chromatophore of Anthocerotaceae possibly suggests the independent origin of this group, and this with other structural facts requires that they be accorded higher rank than heretofore, possibly that of a class coordinate with 'Liverworts on the one hand and the Mosses on the other.' Pteridophytes still consist of three classes, all evidently related to the Anthocerotes, but representing entirely different lines of development. The eusporangiate ferns are regarded as the lowest of the *Filicinae;* Hymenophyllaceae, while of pretty ancient origin, are regarded as an aberrant group; and the *Polypodiaceae* constitute the modern fern type. "That heterospory arose in a number of widely remote groups is unquestionable." This suggests the possibility of a multiple origin of the spermatophytes. "Except for their siphonogamic fertilization, Gymnosperms are much nearer the Pteridophytes than they are to the Angiosperms." "The close resemblance between the Conifers and the Lycopods, especially *Selaginella,* probably points to a real relationship." Cycads are regarded as descended from fern-like ancestors. While the position of *Isoetales* is still in doubt, it is regarded as possible that the Angiosperms may have arisen from them.

This edition without question must prove to be as helpful and suggestive as the one it supplants, and will be used by all students who wish to obtain a clear notion of the structure and relationship of higher plants.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

SCIENTIFIC JOURNALS AND ARTICLES.

THE first article in the September number of the *American Geologist*—'Pleistocene Features in the Syracuse [N. Y.] Region,' by Professor H. L. Fairchild—was prepared for the field program of the meeting of Section E of the American Association for the Advancement of Science at Syracuse last summer and is illustrated by two plates. Professor Charles S. Prosser contributes a paper entitled 'Notes on the Permian Formations of Kansas.' The recent investigations concerning the age of the upper Paleozoic formations of Kansas are reviewed and it is shown that the European and American geologists who have studied the subject most carefully in recent years correlate them with the Permian. 'The Atlantic Highlands Section of the New Jersey Cretacic' is described by Mr. J. K. Prather and is illustrated by three plates. Professor William H. Hobbs publishes 'Contributions from the Mineralogical Laboratory of the University of Wisconsin.' It consists of a description of minerals from various localities, illustrated by one plate of metallic copper from Soudan, Minn., and figures of other minerals.

THE leading article in the September-October number of the *Journal of Geology* is by Professor Rollin D. Salisbury on 'The Mineral Matter of the Sea, with some Speculations as to the Changes which have been involved in its Production.' Dr. Reginald A. Daly contributes a paper on 'The Classification of Igneous Intrusive Bodies,' which is illustrated by nine figures. Mr. J. K. Prather describes 'Glauconite' from the (Cretaceous) Greensands of New Jersey and gives a plate of photomicrographs. 'The Mesozoic of Southwestern Oregon' is described by Mr. George D. Louderback. The rocks are called the Myrtle group or series and the Dillard series. Their lithologic characters, economic relations and areal distribution are well de-

scribed and an interesting comparison is made with 'the standard California type formations.' The concluding paper, the 'Arapahoe Glacier in 1905,' is by Professor Junius Henderson.

The American Naturalist for October contains articles on 'A Peculiar Variation of *Terebratalia transversa* Sowerby,' by H. W. Shimer; 'Studies on the Plant Cell, VIII.,' by Bradley M. Davis; and '*Diadasia* Patton; a Genus of Bees,' by T. D. A. Cockerell. The article on the plant cell is the final one of the series and it is noted that the author has a number of complete sets of reprints, and that enquiries concerning them may be addressed to him at the University of Chicago. Professor Cockerell's article includes a table for the identification of all the species of the genus.

The Museums Journal of Great Britain for October has for its leader an article on 'Local Museums,' by J. Willis Bund, one of several papers dealing with this subject that were read at the last meeting of the Museums Association. The matter is one that should be specially commended to the attention of our schools and colleges, local museums being all too rare in the United States, where much time and effort is thrown away in the attempt to make a small museum cover the universe instead of devoting its energies to the immediate locality. Among the notes American readers will blush to find the prominence given to some comparatively recent occurrences at the Metropolitan Museum of Art.

THE closing (October) number of volume 6 of the *Transactions of the American Mathematical Society* contains the following papers:

MAURICE FRÉCHET: 'Sur l'écart de deux courbes et sur les courbes limites.'

JOHN EIESLAND: 'On a certain system of conjugate lines on a surface connected with Euler's transformation.'

L. P. EISENHART: 'Surfaces of constant curvature and their transformations.'

N. J. LENNES: 'Volumes and areas.'

E. O. LOVETT: 'On a problem including that of several bodies and admitting of an additional integral.'

F. R. SHARPE: 'On the stability of the motion of a viscous liquid.'

A. LOEWY: 'Ueber die vollständig reduciblen Gruppen, die zu einer Gruppe linearer homogener Substitutionen gehören.'

W. B. CARVER: 'On the Cayley-Veronese class of configurations.'

This number also contains: Notes and Errata, volumes 5, 6; Table of Contents, volume 6.

SOCIETIES AND ACADEMIES.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 604th regular meeting was held October 7, 1905, with President Littlehales in the chair.

The evening was devoted to a paper by Professor W. D. Miller, of the University of Berlin, on 'Symbiosis.' He defined symbiosis as a life relationship existing between different kinds of animals or plants, or between animals *and* plants. The relation of the mistletoe to the tree on which it grows, for instance, is a symbiosis. According as advantage or disadvantage accrues to one or the other or to both of the parties concerned the symbiosis is designated as parasitism, commensalism and true or mutualistic symbiotism.

By parasitism we designate that type of symbiosis in which one individual lives at the expense of the other, doing it some harm without making any return; the first being called the parasite, the latter the host. Such is the relation of fleas, lice, bugs, tapeworms, etc., to the human being. By far the most important of this type is that existing between bacteria and the human subject.

By commensalism (*con, mensa*) we designate a symbiosis in which the one party lives from the superabundance or from the crumbs of the table of the other, deriving thereby a benefit from the relationship, but doing no harm and also making no return. In true symbiosis *both parties* derive an advantage from the relationship. Such is the symbiosis between the hermit crab and the sea anemone, between ants and plant lice, etc.

Especial attention was called to the tripartite symbiosis existing between animals, higher plants and bacteria, all animals being dependent upon plants for their food, the higher

plants upon bacteria for keeping up the store of carbon dioxide and of combined nitrogen necessary for plant life, and bacteria dependent upon animal or vegetable matter for their nourishment. The very important and beneficent rôle here played by bacteria in the household of nature has led to the view that they also hold a similar relation to the human body directly, and that the myriads of bacteria found in the alimentary canal not only serve as aids to digestion, but are absolutely essential to this process.

This view was placed upon a scientific basis by Schottelius, who sterilized hens' eggs, hatched them in sterilized incubators and fed them on sterilized food to find that they ate voraciously, but instead of increasing in weight, gradually grew thinner and died in the second or third week. If, however, hen manure was added to the food before the chicks had succumbed, they soon revived and developed rapidly and normally. This experiment proves that bacteria as a matter of fact are necessary to digestion in the case of chicks. It does not follow, however, that the same is true of human beings or of mammalia in general. Thierfelder and Nuttall found that guinea-pigs, taken aseptically from the mother and fed aseptically, developed perfectly normally; this experiment was carried on, however, but for a few days.

There are many other reasons for doubting the usefulness of bacteria as aids to digestion in the human being:

1. The ferments of the alimentary juices ptyalin, pepsin, trypsin, pancreatin, etc.) are capable of carrying on digestion without the aid of bacteria.

2. Digestion by bacteria in the stomach is impossible under normal conditions, on account of the acid reaction of its contents.

3. It is a question whether the bacteria of the intestines, being bathed in foodstuffs already digested do not in a great measure lose the power of peptonizing albuminous substances just as nitrogen-fixing bacteria cultivated on media rich in nitrogen lose the power of fixing nitrogen from the air.

4. By far the great majority of bacteria are found in the large intestines, whereas the digestion and absorption of food take place almost solely in the small intestines. Metchnikoff emphasizes this point in particular and maintains that the large intestines are not only useless, but positively harmful, and even suggests the idea of removing them surgically.

5. Digestion by bacteria is accompanied by the production of substances which are poisonous to the animal body and, for instance, eggs, meat, fish, oysters, etc., undergoing bacteritic digestion (putrefaction) are absolutely unfit for use and in some cases violently poisonous. This fact tallies also with practical experience, which teaches us that wherever bacteria obtain the upper hand and the normal process of digestion is replaced by bacteritic action, either in the stomach or intestines, serious disturbances in the shape of 'spoiled stomach,' headache, nausea, vomiting, diarrhœa, etc., take place.

In the mouth most of the bacteria convert the carbohydrates into lactic and other acids which decalcify the enamel and dentine, so causing decay of the teeth and all its accompanying evils, and we have no evidence whatever that the physiological action of the saliva is furthered by them, in a corresponding degree.

Bacteria are consequently not only not essential to digestion, but they produce serious disturbances in the mouth, stomach and intestines wherever they multiply in excessive numbers. They should consequently be kept down by every means at our disposition and especially as to the mouth; a thorough cleansing of the teeth after every meal not only goes far to keep the teeth and gums in a healthy condition, but contributes much to the general health.

There are, however, in the various cavities of the human body communicating with the outer world (mouth, intestines, vagina) certain bacteria which constitute the peculiar floræ of these cavities and which serve a beneficial purpose by their antagonism to other bacteria.

Some thirty lantern views illustrated the general subject and the speaker's own researches on the bacteria of the mouth; there were several beautifully stained sections of

teeth and microphotographs of other sections showing the infiltration of the dentine with bacteria.

The paper was discussed by Dr. Wiley from the chemical standpoint and by Dr. Kober with reference to the question of soils.

A vote of thanks was tendered the speaker for his very interesting and important paper.

Charles K. Wead,
Secretary.

THE SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE.

The thirteenth meeting of the Society for Experimental Biology and Medicine was held in the Physiological Laboratory of Columbia University, at the College of Physicians and Surgeons, on Wednesday evening, October 18. The president, Edmund B. Wilson, was in the chair.

Members present.—Adler, Auer, Brooks, Burton-Opitz, Calkins, Dunham, Emererson, Ewing, Field, Gies, Hiss, Jackson,[1] Lee, Levene, Levin, Lusk, Meltzer, Meyer, Murlin, Noguchi, Norris, Park, Richards, Salant, Sherman, Sweet, Torrey, Wadsworth, Wilson, Wolf, Woodworth, Yatsu.

Members elected.—Carl L. Alsberg, S. P. Beebe, R. H. Chittenden, P. M. Dawson, W. J. Elser, G. M. Meyer, P. A. Shaffer, Douglas Symmers, L. L. Woodruff.

Abstracts of Reports of Original Investigations.[2]

A Fatigue Wheel. Frederic S. Lee.

The author exhibited a wheel designed for fatiguing mammals by means of voluntary muscular work.

Mutation in the Evening Primrose, Onagra biennis (L.) Scop., with demonstrations. Elizabeth Billings and Frederic S. Lee.

Culture experiments by the authors confirmed MacDougal's discovery of a narrow-leaved mutant of this species. It is possible that a second mutant was found, but further observations are needed to confirm this.

Influence of Thyroid Feeding, and of Various Foods and of Small Amounts of Food upon Poisoning by Acetonitril. Reid Hunt. (Presented by Alfred N. Richards.)

The experiments were performed on mice. *Resistance* to the action of acetonitril was *increased* by administration of thyroid or potassium iodid, or by feeding a carbohydrate diet or a 'limited diet.' Resistance to the action of hydrocyanic acid was *not increased* by administration of thyroid or by feeding a 'limited diet.' Resistance to sodium nitroprussid was *not increased* by administration of thyroid.

Susceptibility to the action of acetonitril was *increased* by administration of thyroidectin and parathyroid and by feeding a protein diet.

A Case of Spirochætal Infection in Man, with demonstrations. Charles Norris.

The author described the first case reported in this country of spirochætal infection verified by microscopical examination of the blood. In July of this year the patient shipped as an assistant steward on the S. S. *Denver,* of the Mallory Line. He stayed five days in Galveston, slept on board and returned on the same steamer to New York. The spirochæte of this case, as seen in the blood of inoculated monkeys, as well as in the human blood, was similar to the spirochæte refringens.

The case directs attention to the probability of mild spirochætal infections, more or less constantly occurring, in sailors or travelers coming from southern parts into New York. The author also called attention to the possibility that spirochætal infection may be communicated, from person to person, through the bites of ticks and bed-bugs, and through wounds.

The Chromosomes in Relation to the Determination of Sex in Insects. Edmund B. Wilson.

Two types of differences between the chromosome-groups of the two sexes occur in the Hemiptera. In one type the females have one

[1] Non-resident.

[2] The abstracts presented in this account of the proceedings have been greatly condensed from abstracts given to the secretary by the authors themselves. The latter abstracts of the communications may be found in current numbers of *American Medicine* and *Medical News.*

more chromosome than the male (*Anasa, Alydus, Protenor*); in the other type both sexes have the same number of chromosomes, but differ in respect to a particular chromosome (the 'idiochromosome'), which is smaller in the males than in the females (*Lygæus, Euschistus, Cœnus, Podisus*). The relations show that these differences must be determined at the time of fertilization, and they arise from the fact that two classes of spermatozoa exist in equal number. In the first type one half of the spermatozoa possess one more chromosome than the other half. In the second type half the spermatozoa possess a large idiochromosome and half a small one. Females are produced in each case upon fertilization by spermatozoa of the first class, males upon fertilization by spermatozoa of the second class.[3]

Experimental Hepatic Cirrhosis in Dogs from Repeated Inhalations of Chloroform. C. A. Herter and William R. Williams.

Repeated chloroform inhalations caused, in dogs, an abundant, richly cellular connective tissue growth between and into the hepatic lobules. The bile ducts were proliferated and the liver cells showed much fatty and hyaline degeneration. The percentage of arginin obtainable from the proteids of the hepatic tissue was less after the chloroform treatment than that obtainable from the normal tissue. The proportion of fat in the liver cells was also reduced.

These observations open the question whether the fatty and parenchymatous degenerations of the liver, which in some cases follow narcosis by chloroform in the human subject, may not occasionally pass on to interstitial cirrhosis—a single narcosis in man being sufficient to induce the primary damage to the protoplasm of the liver cell.

Color Sense in Different Races of Mankind. R. S. Woodworth.

The author endeavored to ascertain whether races of mankind which seem to represent the more primitive stages in human development are specially subject to color blindness. The experiments were carried out in association with Mr. Frank G. Bruner, under the Anthropological Department of the St. Louis Exposition. Of 252 adult male Filipinos (including Christians and Moros), 14, or 5.6 per cent., were red-green blind. Of 75 males of the 'wild tribes' of the Philippines (Igorots, Tinguianes and Bagobos), 2, or 2.7 per cent., were red-green blind. Of 13 male Negritos, none was color blind. A negative conclusion is warranted as to the suggestion that the color sense has developed, within human history, from anything approaching red-green blindness. Various additional results also opposed the view that the color sense has developed within human history from a more primitive type in which only the red end of the spectrum appeared as colored.

On the Practical Concentration of Diphtheria Antitoxin. R. B. Gibson.

The author described a new method for the preparation of concentrated diphtheria antitoxin. The serum is precipitated with an equal volume of saturated ammonium sulfate solution, and the precipitate extracted with a solution of saturated commercial sodium chlorid. The antitoxin globulin dissolves in the latter and the insoluble globulin is separated by filtration. The antitoxin is separated from the filtrate by addition of a half-volume of saturated ammonium sulfate solution, or better still, by addition of acetic acid in the usual way. The precipitate separated by filtration is pressed as dry as possible between absorbent paper and dialyzed a few hours in parchment paper. The resultant dialyzed solution is then neutralized and redialyzed for several days. A quarter of a per cent. of sodium chlorid and some toluol are added and sterilization effected by double filtration through a Berkfeldt filter.

The concentrated antitoxin solution thus prepared contains probably from two to three times the proportion of protein present in normal serum. Large quantities of serum can easily be worked over at comparatively small expense by the method indicated and the product thus prepared is as good or better than ordinary antitoxic serum, in practically all respects.

[3] Science, 1905, XXII., p. 500.

On the Effect of Magnesium Salts upon the Excitability and Conductivity of Nerves. S. J. MELTZER and JOHN AUER.

Numerous applications of solutions of magnesium salts to the sciatic, pneumogastric, depressor and sympathetic nerves of rabbits failed to produce any evidence of excitation, but in each case there resulted sooner or later a profound inhibitory effect upon the conductivity of the nerve under observation. Thus, after application to the sciatic nerve, the conduction of motor and sensory impulses was manifestly inhibited: a strong stimulus applied below the 'block' caused strong contractions of the muscles of the thigh but no pain; when applied above the 'block,' stimulation induced pain but failed to cause contraction. Such effects were obtained with hypertonic as well as with isotonic and even with strongly hypotonic solutions. The weaker the solution the longer it took to establish complete interruption of conductivity. Conductivity could be restored by washing the nerve with Ringer's solution.

WILLIAM J. GIES,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE GEOGRAPHICAL DISTRIBUTION OF STUDENTS.

TO THE EDITOR OF SCIENCE: In Dr. Tombo's interesting article on 'The Geographical Distribution of the Student Body at a Number of American Universities' which appeared in SCIENCE for October 6, 1905, he was careful to state that 'in the case of Harvard University the students of Radcliffe College (undergraduate women) are not included.' May I amend that statement by saying that only men were counted in the Harvard table, the graduate students as well as the undergraduate students of Radcliffe College having been excluded. Had these 407 students been included, several comparative statements in the article would have been affected. Harvard would have led in the North Atlantic division by 47, and would have gone from fourth place to third place in the South Atlantic division. In the line of grand totals Harvard would have led by 361, Columbia being second and Michigan third. Had women been wholly omitted or separately counted in Dr. Tombo's table, several rearrangements would obviously have been necessary.

JEROME D. GREENE.
HARVARD UNIVERSITY.

THE MAKING OF LANTERN SLIDES.

TO THE EDITOR OF SCIENCE: Every one knows how troublesome it is, in the making of lantern slides from a variety of objects, to accurately center the images on the negative plates; how very troublesome it is to get a centered lantern slide from an eccentric negative, and how much time is required in cutting paper mats for bounding the field of a lantern slide. For several years I have employed a method which I find obviates these difficulties almost completely.

In making my negatives I take pains to get the desired size of image, but do not take the trouble to center the image upon the spot where the negative plate is expected (?) to be.

I take these negatives and trim them by means of a cutting diamond to the size of the transparent square desired on the lantern slide. I can trim thirty negatives in fifteen minutes.

I then take my lantern plates, lay them film side up on a black ground, lay a trimmed negative centrally on each, and print by a light held above.

The resulting positives are perfectly centered, and the desired field is sharply bounded by a nearly opaque border which is as satisfactory as a carefully cut paper mat.

W. S. FRANKLIN.

SPECIAL ARTICLES.

ORTHOGENETIC VARIATION.

SINCE I am responsible for the term 'orthogenetic variation,' whilst the far greater idea of 'orthogeny' falls to the credit of the late Theodor Eimer, I am anxious that it should not be misrepresented.

The paper by Mr. Robert E. Coker, entitled 'Gadow's Hypothesis of Orthogenetic Variation in *Chelonia,*' Johns Hopkins University Circular No. 178, May, 1905, calls for some remarks on my part by way of protest and

correction. In my paper[1] I concluded as follows, concerning the observed variations in the number and arrangement of the scutes of the loggerhead, *Thalassochelys caretta:*

These variations from the normal type all lie in the direct line of descent, and the more serious the variation, the further back it points. Moreover the changes necessary to turn any given variation into another one less abnormal until ultimately the normal condition is reached, are not erratic, but stand in strict correlation with each other and proceed strictly on definite lines. I, therefore, call this kind of atavistic variation orthogenetic.

Further, I had suggested that the individual, abnormal turtles 'grow out of these irregularities by the reduction or squeezing out of certain of the scutes,' and I concluded as follows:

Of course there is no proof of what I have tried to explain. Comparative anatomy and common sense tell us it is so. But common sense is not evidence in a sceptical court. The only way of proving the correctness of the view explained in this paper would be to take a number of abnormal turtlets and to watch, while they are growing up, if and how they mend their irregular shells and become normal.

I think I had stated the case fairly. It left no doubt about the definition of at least one kind of orthogenetic variation. Of course, it can not be expected that a turtlet with, say, twenty-four dorsal scutes can, during its growth, reduce them to the normal number of sixteen. I had said as much. Many a turtlet probably sticks fast during the mending process. Otherwise there could be no abnormal adult specimens, if my surmise is correct. But if they do amend the number of scutes, these cases of orthogenetic variation are simply ontogenetic stages, passing reminiscences of earlier, phylogenetic conditions. We ourselves begin with an embryonic tail of numerous metameres, and their ultimate reduction to five, four, three or two free caudal vertebræ falls under the same category of variation.

Orthogenetic variation implies something progressive, no matter whether it means increase or decrease in numbers. A case of increasing tendency is, for instance, the striation of certain species of the lizard genus *Cnemidophorus,* of which the small *C. deppei* varies in the possession of seven to eleven white stripes, the eleven-striped individuals and the six-striped *C. sexlineatus* representing the two extremes. A study of these lizards has convinced me that in many cases a limited increase in the number of stripes takes place during individual growth. For detail I must be permitted to refer to my paper.[2]

Mr. Coker does not believe that orthogenetic variation (or, as he says, 'determinate') exists in the *individual* turtle. He holds that my assumption can not be proved by percentages. Whilst I rejected the notion that the irregular number of scutes has any serious influence upon the successful life of the turtles, he thinks it is quite conceivable. But 'at least the more extreme cases may be but one of the evidences of a congenital weakness,' so 'that a greater proportion of abnormal than of normal turtles fail in the struggle.' Of course, this may be the case. But how are we to find it out, unless we watch a number of them growing up? The fact remains that there are adults with very abnormal scutes which do very well. Mr. Coker is indignant at my saying that no less than fourteen per cent. of large turtles were wrong, when I had only one such abnormal specimen out of seven large specimens. I grant that this was the wrong way of putting the case. Let me, therefore, mend the sentence as follows:

No less than twenty-two per cent. of turtles of the considerable size of two feet and upwards, are wrong in their scutes, and do, or did very well, for all we know to the contrary.

On the other hand, he found that of 28 embryos of *T. caretta,* of one nest, only 9 had more than the normal number of 16 scutes, with totals of 17, 18, 19 and 20; whilst two had each one costal too few, making a total of

[1] 'Orthogenetic Variation in the Shells of *Chelonia,*' Willey's *Zoological Results,* Pt. III., May, 1899, pp. 207–222, pls. XXIV.–XXV.

[2] 'Evolution of the Colour-pattern and Orthogenetic Variation in Certain Mexican Species of Lizards with Adaptation to their Surroundings,' *Proc. Roy. Soc. London,* Vol. 72, May, 1903, pp. 109–125, pls. 3–5.

15 costals and neurals. These two specimens are really very interesting, since they fill the gap in my table, between totals of 16 and 14. This reduction is due to the falling out of a pair of costals, as is shown by comparison of *Thalassochelys* with *Chelone*. This shortage of one costal scute in Coker's turtlets is, however, not 'precocious,' since 16 is the normal number in this species, but it is rather prophetic so far as Cheloniidæ are concerned. Therefore, no need for him to say that it would be difficult to explain this deficiency as precocity. But I am at a loss to understand what bearing his table on page 20 has upon my hypothesis, considering that all his turtlets were embryos, most of them still unripe. I trust that he does not impute to me the belief that the turtlets should begin to mend their ways before they are born.

The fact remains that, with the addition of Coker's turtlets to the 76 specimens enumerated in my table, the percentage of specimens with supernumerary scutes still decreases steadily with age. Of course, such calculations are always precarious unless they are based upon very great numbers, and it is not unlikely that the amount of variation in the members of one brood differs much according to clans, or regions, not to mention the parents about whom we know nothing.

	Per cent.
Of 73 embryos or new born, 53 are abnormal	=7
Of 9 specimens from 3 to 8 inches incl., 3 abnormal	=33
Of 19 specimens from 8 to 24 inches incl., 5 abnormal	=22
Of 9 specimens from 24 inches to "large," 2 abnormal	=24
Of 7 large specimens, only 1 abnormal	=12

Still more surprising are Mr. Coker's conclusions as drawn from the examination of 250 specimens of the diamond-back terrapin, *Malacoclemmys centrata* Latr. Examination of 250 individuals of all ages and sizes in the condition just as they were caught. He found, however, a few cases which indicate that partial fusion, or division, of neighboring scutes has been going on during the creature's life. The occurrence of reduction by fusion, of increase by division during the individual's growth is, therefore, demonstrated. Would it not go a long way in support of my hypothesis if actual observation showed that the total number can be reduced during life by one single scute? I ought to feel grateful for such a help, willing to waive the experimental proof, and be glad to accept fusion instead of my suggested squeezing out. Lastly, I ought to feel crushed by Mr. Coker's table, which shows, if anything at all, that in the diamond-back the scutes seem to increase instead of decreasing with age. The author himself is confirmed in the 'belief that in *Malacoclemmys* we do not have orthogenetic variation in the sense that there is normally in the individual life history a progressive reduction in the number of scutes.'

No, of course not. The whole investigation has ended in a farce. A beast which frequently goes in for the longitudinal splitting of its true neural scutes is not a fit subject for the study of orthogenetic variation. This is malformation pure and simple; it is as little atavistic, or in line with anything, as are six fingers in man, or five toes in fowls.

I do not profess to know what the diamond-backs are after. Perhaps this crazy splitting may in time establish a new type of chelonian with a completely double series of neural scutes! However, Coker himself did not fail to see that in these creatures 'the tendency is not toward, but away from the type.' He should, therefore, have ruled them out of court. But there surely is also a *beyond the type*, and this seems to have puzzled him sorely, as is shown by his footnote 3 on page 18 of his paper. For instance, if (whether congenital, or due to fusion, division or suppression) a loggerhead or other marine turtle has only five neurals, that would be something beyond the type of Cheloniidæ, and in this respect very abnormal, but still orthogenetic, since reduction to five neurals has been realized and has become the normal condition in *Pleurodires* and even in certain species of *Testudo*. Such a case in a marine turtle would be, so to speak, prophetic, and quite reasonable, and a trained morphologist would recognize that such things are 'quite in the line' of tortoises.

My appeal to comparative anatomy and common sense has been of little avail. I venture to make a practical suggestion. The eastern states are the home of many kinds of

chelonians. Ponds, creeks, marshes and rivers are swarming with them, and surely a place could be found which only requires fencing to be turned into a scientific, experimental 'crawl,' where some hundreds of turtles of a suitable kind could be turned loose, labeled, of course, and examined from time to time whether any of them are amending their abnormal shells. For physical reasons such an experiment of possibly far-reaching, fundamental importance, can not be made in Europe.

H. Gadow.

Cambridge, Eng.,
September 4, 1905.

NOTE ON VECTOR SYMBOLS.

The question of notation was always of importance, and the introduction of new methods depends a good deal on it. It is, of course, highly desirable to have *one* system of notation used by all the scientific world, but at the same time it is also desirable that the system in use shall be a simple and easy one.

The vector-analysis becomes more important every day in the study of physics. It is, therefore, necessary to have a vector notation as simple as possible. The notation used today is far from being uniform, and still the tendency is towards the introduction of German letters for the symbolization of vectors. May be that when printed, the German letters look well, and are well distinguished from the Latin alphabet. The student, no matter of what nationality, can learn to recognize them just as he learns to recognize the Greek alphabet. But the question is the *writing* of the German characters. Those that try to picture a German print-letter on the board when necessary to use the vector symbols in a lecture before a class will know how difficult this is. And to use different signs when written and different signs when printed does not seem reasonable. Why not use as symbols for vector quantities the Latin alphabet? The Latin alphabet is almost universal, and there is no difficulty whatever to write this alphabet. I, therefore, propose—with Professor Karl Heun in Germany—to use the following notation for vectors, a notation as simple as it can be.

All vector quantities are written as follows: $\bar{a}$, $\bar{b}$, $\bar{d}$, $\cdots$, $\bar{A}$, B, G, $\cdots$, and their tensors respectively: a, b, d, $\cdots$, A, B, G, $\cdots$. The scalar-product of two vectors $\bar{a}$ and b is written: $\bar{a}\bar{b}$, which, by definition, is $= a\,b \cos (a, \bar{b})$. The vector-product of two vectors $\bar{a}$, $\bar{b}$ is written thus: $\dot{a}\dot{b}$, and because it is itself a vector it can be written: $c = \bar{\bar{a}\bar{b}}$. The tensor of this vector: $c = ab \sin (\bar{a}, \bar{b})$. The unit vector can be written, for instance, $\bar{a}_1$, $\bar{b}_1$, $\cdots$, so that $\bar{a} = a\,\bar{a}_1$, $\bar{e} = e\,\bar{e}_1$, $\cdots$.

The advantage and simplicity of this system of notation speak for themselves.

H. Schapper.

University of Arkansas,
Fayetteville, Ark.,
August 8, 1905.

THE OCCURRENCE OF ICHTHYOSAUR-LIKE REMAINS IN THE UPPER CRETACEOUS OF WYOMING.

Through the kindness of Professor S. W. Williston, I have recently received two fragmentary vertebræ found by Mr. W. H. Reed in the Benton Cretaceous near the north end of Medicine Bow Mountains. Although very fragmentary, these vertebræ appear to represent a genus allied to *Ichthyosaurus*. As this reptilian group has not been known in North America in beds as late as the Benton, the discovery is of considerable interest.

The larger fragment consists of the upper three fourths of a deeply biconcave vertebral centrum apparently from the cervical or anterior dorsal region. The centrum is very thin antero-posteriorly, and in this respect somewhat resembles the corresponding centra in *Baptanodon discus*. The sides are considerably damaged, so that it is not possible to make a definite statement concerning the rib articulation, but it seems to have been double, as in *Baptanodon*. A foramen close to the upper end of the diapophyses is larger than any I have seen in this position in the typical Ichthyosaurs, and adds somewhat to the difficulty of making a definite determination of the relationships of this form.

When more material is available it will be interesting to learn whether this form really represents a true *Ichthyosaurus* or possibly a more highly specialized form of *Baptanodon*

than those which we know from the Baptanodon beds. Should it be *Baptanodon*, it will probably show some extreme specializations, as the time separating the Benton from the Baptanodon beds is considerable.

JOHN C. MERRIAM.

QUOTATIONS.

TRUSTEES AND FACULTIES.

THE *Review* is greatly interested to learn that a national congress of the trustees of American universities is to be held this month at the University of Illinois in connection with the inauguration of its new president, and that this conference will be devoted to a discussion of the best form of administration of higher educational institutions and of the proper share of trustees, faculty and alumni in their government. Such a discussion is of especial interest at this time to institute men because of the unfortunate divergence in opinion of the corporation and faculty as to the future educational policy of the institute, and because of the absence of any intermediate body or other means of conference by which an intimate exchange of opinions might take place, and the differences in point of view of the two bodies might be reconciled or compromised.

Whatever be desirable from an ideal standpoint, the practical conditions surrounding American education, especially the legal requirements and the constant need of renewed financial support, will undoubtedly make necessary the existence of a board of trustees in our educational institutions. The proper relations of such a board to the faculty and alumni is a large question, and one which must receive a somewhat different answer in different institutions. The *Review* believes, however, that the following general principles are vital to the soundness of our educational system. The board of trustees and the faculty must be coordinate bodies, the latter being in no sense subordinate to the former. There must be as sharp a division of functions as is practicable, the trustees dealing exclusively and finally with legal and financial questions, and with the appointments of president and faculty, and the faculty having exclusive jurisdiction in purely educational questions, including not merely the details of instruction, administration and student government, but all matters relating to curriculum, courses of study offered and degree requirements. General questions as to educational aims, and all the numerous questions involving both financial and educational considerations should be discussed by both bodies, and should be acted upon only after substantial agreement has been reached. And to this end there must be established conditions of harmonious cooperation and frequent opportunities for intimate contact and exchange of views. This would seem to be best obtained by the formation of an advisory council—consisting of five or six members from each body, with the president as chairman—which, after thorough discussion should make recommendations both to the trustees and to the faculty. Finally, the alumni not only should be urged to participate in the conduct of the social and athletic life of the students, and to recommend improvements in the courses of study, but they should also be given some direct and substantial share in the government of the institution.—*The Technology Review*.

THE RHODES SCHOLARSHIPS.[1]

THE opening of the present term at Oxford will add 67 new scholars to the list of those in residence under the bequest of the late Cecil Rhodes. Allowing for the withdrawal of a few of the German scholars who find it more in accord with their University system at home to take only a two years' course instead of the three years to which the scholarship entitles them, there remain over from last year's students 79, so that for the academic year 1905–6 the whole number in residence will be slightly under 150. The full list is not, however, yet complete. In 1906, when scholars are elected only for the Colonies and Germany, there will be a further addition of more than 30. As several of the communities concerned have in the last two years failed to send forward a candidate qualified to enter Oxford,

[1] The London *Times*.

the whole number will be still further increased in later years when this deficiency has been repaired. The total number for whom permanent provision is made is about 190, and no doubt this *maximum* will be reached before many years have elapsed.

In the election of scholars the only qualifying test in scholarship fixed by the trustees is the Oxford Responsions standard. An exception to this rule has hitherto been made in the case of South Africa and one of two Australian colonies; but after this year the test will be everywhere applied, except in Germany, where the selection of scholars was assigned by Mr. Rhodes to the Emperor himself. In all other cases a local committee of selection, usually composed of educational experts and sometimes of a school or university faculty, completes the election from among the candidates who have passed the preliminary test; and these committees are directed to select on the basis suggested by Mr. Rhodes. They are free to apply for purposes of comparison any further educational or other test they think desirable beyond that exacted by the trustees.

For 1904 five states or territories of the American Union failed to qualify a candidate on the Responsions standard, while no fewer than ten failed in 1905. The states thus failing in 1905 were Alabama, Arizona, Arkansas, Montana, Nevada, North Dakota, Oregon, South Dakota, Utah and Wyoming, mostly, it will be observed, the newer western states. Among the colonies Rhodesia has had some difficulty in filling up its annual quota of three scholars, and one scholarship is vacant this year. The organization of secondary schools has barely begun there, and in the meantime Rhodesian boys studying in England, but whose parents are spending their lives in the colony, have been considered eligible. This condition will be modified with the advance of Rhodesian education. The only other colonial community which has yet failed to send a scholar is the northwestern territory of Canada, which furnished a successful candidate in 1904, but none who qualified in 1905. Fifteen American scholarships and two colonial scholarships are therefore vacant at the present time through lack of duly-qualified scholars. When scholarships have once lapsed through failure of this kind they are not filled up in the succeeding year, but only in the regular cycle of appointment, as any other method would be unfair to prospective candidates for any given year.

THE RESEARCH LABORATORY OF PHYSICAL CHEMISTRY OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

Several changes have taken place in the staff of the Research Laboratory of Physical Chemistry of the Massachusetts Institute of Technology. Professor W. D. Coolidge has accepted a position in the Technical Research Laboratory of the General Electric Company at Schenectady, where he will be closely associated with Dr. W. R. Whitney. To Professor Coolidge has been due in large measure the development of one of the most important lines of work in progress in the research laboratory of the institute—the investigation of the conductivity of aqueous solutions at high temperatures. This research will be continued not only by several investigators at the institute, but also by Professor Coolidge at Schenectady. Mr. Yogoro Kato, who has also been engaged on the conductivity investigation for two years, has accepted a position in the Technical High School of Tokio, where he will have charge of the work in electrochemistry. Dr. Wilhelm Böttger returns as Privatdocent to the University of Leipzig, at which he will conduct one of the laboratory courses in analytical chemistry. In place of these retiring members, the following new appointments to the research staff have been made: William C. Bray, B.A., Toronto '02, Ph.D., Leipzig '05; Guy W. Eastman, S.B., M.I.T. '04; Gilbert N. Lewis, Ph.D., Harvard; Edward W. Washburn, S.B., M.I.T., '05. Mr. Roy D. Mailey has been promoted to the position of research associate. Seven candidates for the degree of doctor of philosophy are now pursuing work in the laboratory. By them and by the regular research workers, the investigations mentioned a year ago in Science are all being continued, and one new line of work has been entered upon, namely, a study

of the hydration of salts in aqueous solutions. This subject, which constitutes one of the most important as well as one of the most difficult of the unsolved problems relating to solutions, is being attacked by two independent methods by Mr. Edward W. Washburn and Mr. Richard C. Tolman. A series of eight articles describing the researches made in the laboratory during the last two years is about to be submitted to the Carnegie Institution for publication. The research laboratory has been assisted on the financial side by a further grant of five hundred dollars from the trustees of the William E. Hale research fund, by a gift of two hundred dollars from Mr. Samuel Cabot and by one of three thousand dollars from one of the professors of the institute.

THE AMERICAN SOCIETY OF NATURALISTS AND AFFILIATED SOCIETIES.

THE American Society of Naturalists and affiliated societies will meet at the University of Michigan, Ann Arbor, in Convocation week. The Central Branch of the society will meet, but we understand that the Eastern Branch will hold no meeting this year. There will meet in conjunction with the American Society of Naturalists the American Zoological Society, the American Physiological Society, the American Association of Anatomists, the Society for Plant Morphology and Physiology and the American Society of Bacteriologists, the latter society having suspended its rules of meeting only in the eastern states.

THE American Psychological Association and the American Philosophical Association, which have in recent years met with the Naturalists, will meet this year at Harvard University. On this occasion Emerson Hall, the new building for philosophy and psychology, will be formally opened.

THE NEW ORLEANS MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE people of New Orleans have organized local committees to take charge of the arrangements for the meeting of the association, which will be held from December 29 to January 4. The permanent secretary writes from New Orleans that the local committees are enthusiastic and will work hard for the success of the meeting. That it will be an important and successful meeting is assured, provided the attendance is satisfactory.

The question of railroad rates has not as yet been thoroughly settled, but it seems likely that a one-fare rate will be secured from most of the railroad associations. The opportunity, therefore, to members of the association (especially from the northeast) to visit New Orleans, will be an exceptional one. New Orleans is a most interesting city on account of its historical associations, its cosmopolitan population, its extraordinary natural advantages, the wonderful flora of its parks and surroundings and the many important industries which center at the mouth of the great waterway of the United States.

Members who have not visited New Orleans should take advantage of this chance and members who are familiar with the city will gladly greet the opportunity to revisit it. Nearly all of the sections and affiliated societies will be accommodated in the lecture halls of the Tulane University (which is the state university of Louisiana) with new and well-equipped buildings. It is likely that the meeting of the Social and Economic Section will be held in the board of trade rooms in the central part of the city. The university itself is within easy access of the large hotels by trolley, the time occupied in the journey being about twenty-five minutes. The St. Charles Hotel has been chosen as hotel headquarters and promises of low rates to members are also made by the Grunewald, Cosmopolitan and other hotels. It will be well for members to write well in advance and engage rooms.

The honorary president of the local committee will be President E. B. Craighead, of the Tulane University. The executive president will be Professor George E. Beyer, of Tulane University; secretary, Henry M. Mayo, of the New Orleans Progressive League, and treasurer, Mr. Clarence F. Low, of the Liverpool, London and Globe Insurance Company.

The subcommittees are formed as follows:

Executive Committee.—The general officers and the chairman of the subcommittees.

Reception and Entertainment Committee.—Dr. Isadore Dyer, Professor John R. Ficklen, Mrs. I. L. Lyons, Miss Ida Richardson, Mrs. J. P. Richardson, Miss Kate Minor, Mrs. J. R. Ficklen, Judge Charles Fenner, Mr. George Kanshe, Miss Kate Gordon, Miss Grace King, Mrs. M. M. Davis, Mr. Charles Godchaux, Mr. E. B. Cushing, Professor B. V. B. Dixon, Mr. Lucien Lyons, Mrs. Craighead, Mr. Theodore Lyons, Captain I. L. Lyons.

Hotels and Boarding Houses.—Andrew Blakley, Theodore Grunewald, Joe Voegtle, J. K. Denechaud, Henry M. Mayo.

Meeting Place and Equipment.—Professor Wilkinson, Professor Creighton, Professor Caldwell, Jr., Professor Anderson, Professor Smith, Professor Barnett and Professor Miller.

Membership Committee.—James H. Dillard, L. W. Wilkinson, Professor W. B. Smith and Dr. J. W. Caldwell.

Transportation Committee.—Hunter C. Leake, Charles Marshall, J. Kemp Ridgely, Robert Strong, E. B. Cushing, D. C. Cunan.

Press and Printing.—John Dymond, Sr., John Dymond, Jr., Ashton Phelps, T. G. Rapin, Major T. E. Davis, Captain J. W. Bostick, Page M. Baker, Norman Walker, Robert Ewing, J. M. Leveque, J. Walker Ross, Henry Steir, Professor J. Hanno Deiler, Professor Alcée Fortier, A. Capdeville, Dr. Martin A. Aldrich, Dr. J. S. Barnett, Professor Walter Miller.

The executive committee of the council of the association consisting of the permanent secretary, the general secretary, the secretary of the council and all secretaries of sections will meet at the office of the permanent secretary in the St. Charles Hotel, at noon, on Thursday, December 28, to revise the program for the week and to make the final arrangements for the opening session of the association, which will be held in one of the large halls of the city, at ten o'clock, on Friday, December 29. The meeting will be called to order by the retiring president, Professor Farlow, who will introduce the president elect, Professor C. M. Woodward. Addresses of welcome will be delivered by Governor Blanchard, by President Craighead and by Mayor Behrmann, and to these addresses President Woodward will reply. The addresses of the vice-presidents of sections will be distributed throughout the week in accordance with the plan adopted at the Philadelphia meeting of the association.

Special features of the meeting will include the address of the retiring president, Professor Farlow, and the public evening lectures will include, if possible, one by some eminent authority on the 'Panama Canal' and another on the subject of 'Irrigation and Drainage.' There will also be an important symposium under the auspices of Section K on the subject of yellow fever and other insect-borne diseases. In this discussion, it is hoped that prominent specialists from the north will take part and that addresses will be made by the men who have borne the brunt of the fight against yellow fever in New Orleans during the past summer, especially Dr. J. H. White, who has had charge of the situation for the Public Health and Marine Hospital Service, Dr. Souchon, president of the State Board of Health, and Dr. Kohnke, the health officer of New Orleans, and others.

The local committee will arrange for receptions and excursions to places of interest and route maps of the city will be prepared indicating points of historical interest. The folklore of Louisiana will be handled in an especially interesting manner before Section H.

The following affiliated societies have notified the permanent secretary that they will meet with the association at New Orleans: the American Chemical Society, the Botanical Society of America, the Fern Chapter, the Association of Economic Entomologists, the Southern Society for Philosophy and Psychology, the Society for the Promotion of Agricultural Science.

SCIENTIFIC NOTES AND NEWS.

Lord Rayleigh has been recommended by the council for election as president of the Royal Society at the anniversary meeting on November 30.

LORD KELVIN has been elected president of the Royal Society of Edinburgh.

THE Janssen medal of the French Astronomical Society has been awarded to Mr. Percival Lowell for his work on Mars.

DR. JOHN BEDDOE, F.R.S., has been presented with the Huxley medal of the Anthropological Institute for his services to anthropology.

WE learn from *Nature* that a gathering of the old pupils of Mr. Francis Darwin, F.R.S., formerly reader in botany, was held in the botany school of the University of Cambridge on October 28, when his portrait, by Mr. W. Rothenstein, was presented to the botanical department by a body of subscribers, all formerly his pupils. To Mr. Darwin himself was presented a book containing autographs of his pupils. Speeches were made by members of the staff and by other botanists regretting the severance, after twenty-one years, of Mr. Darwin's connection with the botanical department.

PROFESSOR ADAM POLLITZER, of Vienna, well known for his researches on otology, recently celebrated his seventieth birthday, and in accordance with the Austrian law will retire from academic service at the end of the present year.

PRESIDENT DAVID STARR JORDAN, of Stanford University, left Palo Alto on November 8 for New York, where he will attend the meeting of the trustees of the Carnegie foundation for pensioning college professors.

The Observatory says that among visitors at Greenwich lately were Professor W. J. Hussey, professor of astronomy at the University of Michigan, and Professor W. W. Campbell, director, and Dr. and Mrs. Perrine, of the Lick Observatory. Professor W. S. Eichelberger, of the U. S. Naval Observatory, and others who attended the conference at Oxford in September have also visited Greenwich.

PROFESSOR WILHELM OSTWALD is delivering at the Massachusetts Institute of Technology a course of six lectures in German on 'The Historical Development of Chemistry.' The course began on November 9.

BARON ERLAND NORDENSKJOLD has returned from an eighteen months' anthropological expedition to the Andes and the northern forests of Bolivia, where he was accompanied by Lieutenant E. de Bildt and Dr. Holmgren.

A MEMORIAL bust of the late Dr. Joule was unveiled on October 28 at Sale, near Manchester. The ceremony was performed by Sir William Bailey, president of the Manchester Literary and Philosophical Society, who delivered an address.

PROFESSOR RALPH COPELAND, astronomer royal of Scotland and professor of astronomy at the University of Edinburgh, died on October 27, at the age of sixty-eight years.

PROFESSOR F. W. HUTTON, F.R.S., curator of the Museum at Christchurch, New Zealand, and president of the New Zealand Institute, died on October 27, at the age of sixty-nine years. Professor Hutton was well known for his contributions to geology, zoology and the theory of evolution.

THERE will be a civil service examination on December 6 to fill a vacancy in the position of computer (male) in the Forest Service at $1,000 per annum.

AT a meeting of the council of the Royal Society on October 26 the treasurer announced that he had received from Mrs. Tyndall a check for £1,000, which, in accordance with the wishes of the late Professor Tyndall, she desired to have applied to the general purposes of the society.

AT a meeting on October 31 of the general committee of the British Association the following resolution, which has reference to the meeting of the association in 1907, was unanimously adopted: "That having regard to the fact that no meeting of the association has as yet been held in Leicester, the general committee decides to accept the cordial invitation from that town, and at the same time expresses its most hearty appreciation of the kind and courteous invitation from the city of Dublin, and ventures to express the hope that the invitation may be renewed at an early date."

THE telescopes and instruments of the late Dr. Isaac Roberts were sold by auction by

Mr. J. C. Stevens on October 17. The equatorial with the 20-inch reflecting telescope and the 7-inch Cooke refractor are now in the possession of Mr. James Bower, an amateur astronomer of Norwich.

It had been expected that the Simplon tunnel would be opened on January 1, but it is now announced on official authority that the line will not be ready before May 1. Hopes are entertained that this delay will enable electric traction to be employed from the first, a plan which temporarily had been abandoned, but which the Italian government is understood to be desirous of seeing realized.

According to a cablegram from Brussels, the Belgian government has authorized an international lottery to collect $2,000,000 for an expedition to the North Polar regions.

The Liverpool School of Tropical Medicine announces that it proposes to appoint two qualified medical practitioners to work on trypanosomiasis and spirillosis at the school. The salary to be paid is at the rate of £100 per annum.

Mr. Henry F. Shaw, of Boston, well known in railway circles for his devotion to the problem of balancing the reciprocating parts of locomotives, has presented to Purdue University a model locomotive embodying his latest design. The model is constructed on the scale of one inch to the foot, and is an excellent piece of work.

The inaugural meeting of the British Science Guild was held at the Mansion House, on October 30, under the presidency of the Lord Mayor of London. Sir Norman Lockyer, in presenting a report on the action of the organizing committee, said, according to the *British Medical Journal,* that the object of the Guild was to encourage the application of scientific method to practical affairs, and especially to education, which should be based upon things and thinking as well as upon words and memory. On the motion of the Bishop of Ripon, seconded by Lord Strathcona and Mount Royal, and supported by Sir W. Mather, the Right Hon. R. B. Haldane, K.C., M.P., was unanimously elected first president of the British Science Guild. In acknowledging his election, Mr. Haldane said that the object of the Guild would be the bringing of method, the bringing of thinking, into the modes of government in public affairs and private industries alike. After referring to the deficiencies in scientific education of the officials of the treasury, the home office and the board of trade, Mr. Haldane said that he believed that things would not be put right until a scientific corps was formed under a permanent committee, just as the defence committee was under the prime minister. Such a corps should consist not merely of officials but of the most eminent scientific men, who would serve in it because they felt that they were honored and put on a proper footing and recognized as a body of men charged with the duty of advising the great department of state on organizing the scientific work of the country. Subsequently a number of vice-presidents and officers of the guild were elected, and a vote of thanks to the Lord Mayor brought the proceedings to an end.

Reuter's representative has had an interview with M. Henryk Arctowski, a member of the scientific staff of the Belgian Antarctic expedition of 1897–1899, which was the first to winter in the south polar regions. M. Arctowski is actively interested in the new scheme of polar exploration as set forth in September at the Congress of Mons, in which King Leopold took such great interest and attended personally. M. Arctowski has just visited London in order to confer with several geographical authorities on the possible outcome of the resolution taken at Mons. He proposes to begin the systematic exploration of the Antarctic regions by a preliminary circumpolar expedition which, organized in Belgium, would leave Antwerp next autumn with the object of exploring the most unknown sections of the south pole in view of finding new lands and suitable places for the establishment of subsequent wintering stations. The most interesting part of M. Arctowski's project is his idea of utilizing an automobile, of special construction, to penetrate into the interior of the Antarctic Continent. He thinks that if this experiment were successful, automobiles could be used on the inland ice to

transport all the material necessary for the establishment of a far advanced station in the interior, whence further explorations could be made. Scientifically this station near the south pole would add very much, by its observations, to the *data* collected by the several expeditions which would be sent out in accordance with the plan of the Association of Polar Explorers.

THE London *Times* says that in view of the suggested transmission of disease by telephone mouthpieces, the General Electric Company has brought out an instrument in which any danger of the sort is avoided by the simple expedient of abolishing the mouthpiece altogether. The receiving and transmitting apparatus is combined in a small metal case, shaped like a watch, which is held continuously to the ear both in speaking and in listening, the transmitting microphone being made so sensitive that it becomes unnecessary to concentrate the sound waves on it by the aid of any mouthpiece such as is ordinarily used. Mounted on a handle, with a speaking key, the new arrangement is exactly similar to the common combined receiver and transmitter, except that there is no mouthpiece, and the speaker, as it were, addresses himself to the world at large, instead of talking into a trumpet-shaped orifice.

A REPORT on the production of natural gas in this country during 1904 will soon be published by the United States Geological Survey. This paper, of which Mr. F. H. Oliphant is the author, contains much information about the composition, production, consumption and uses of this ideal household fuel. The United States is fortunate in its possession, as it produced 98 per cent. of the entire known world's production of natural gas in 1904. This production amounted approximately to 256,645,000,000 cubic feet, or 6,159,480 tons of 2,000 pounds. The value of this production was $38,496,760, which was an increase of $2,688,900 over the value of the 1903 production. There was much active work in 1904 in the new fields of central Ohio and southeastern Kansas. In Kansas a number of remarkably large wells were developed. A large amount was expended in drilling wells, extending many pipe lines, and piping cities and villages in these states. In West Virginia a considerable number of new wells of large capacity were drilled and connected to the main lines. Four states, Pennsylvania, West Virginia, Indiana and Ohio produced 93.3 per cent. of the entire value of natural gas produced in the United States in 1904. The output of Pennsylvania alone represented 47 per cent. of the entire value. This is interesting when it is remembered that Pennsylvania is the oldest state producing natural gas in large quantity.

PROFESSOR SILVANUS P. THOMPSON writes, according to the London *Times*, "No one seems to have recalled, in connection with the commemoration of Sir Thomas Browne, at Norwich, that he was the first person to use the word 'electricity' as a noun. Gilbert and others who followed him had adopted the term 'electrics' to denote substance which, like amber, became attractive when rubbed; but they had used no name for the unseen itself. The first occurrence of the substantive in English (or, for that matter, in any language) occurs on page 79 of the 'Pseudodoxia Epidemica' (1646) in the following passage: 'Glasse attracts but weakely though cleere, som slick stones and thick glasses indifferently; Arsenic not at all; Saltes generally but weakely, as Sal Gemma, Alum, and also Talke; nor very discoverably by any friction: but if gently warmed at the fire, and wiped with a dry cloth, they will better discover their Electricities.' Sir Thomas Browne also claims the gratitude of posterity for the narration on page 76 of his own experiments to expose the fable of the wireless telegraphing by sympathy between two magnets."

UNIVERSITY AND EDUCATIONAL NEWS.

MR. JAMES SPEYER has given to Columbia University $50,000 to endow the Theodore Roosevelt professorship of American history and institutions at the University of Berlin. Dr. J. W. Burgess, professor of political science and constitutional law and dean of the faculty of political science at Columbia Uni-

versity, has been nominated as the first incumbent of the chair.

A technical high school with accommodations for 1,200 people will be erected in Newark, N. J.

An anonymous gift of £50,000 has been made to the University of Birmingham toward the completion of the new building. The present donation makes the fourth of £50,000 which has been received. The other donors were Mr. Carnegie, Sir James Timmins Chance, and 'Anonymously.' Up to the present the council have authorized an expenditure on the new University at Bournbrook of £250,000 on buildings and £100,000 on equipment. By the latest donation the total fund in the possession of the council is increased to £450,000. In addition the city council have given a halfpenny rate, which is equivalent to £6,000 a year, and the county councils of Staffordshire and Worcestershire are subsidizing the university to the amount of £500 a year each. The Guardians of the Standard of Wrought Plate have decided to make a grant of from £200 to £300 a year.

The new zoological department of the University of Liverpool, including the museum and laboratories of zoology and of the practical applications of zoology, will be opened on November 18 by the Earl of Onslow.

On October 16 Bellevue College, at Bellevue, Nebr., celebrated the twenty-fifth anniversary of its founding with appropriate ceremonies, including an historical address by Rev. D. R. Kerr, D.D., former president of the college and now president of Westminster College, Fulton, Mo. On the same occasion occurred the inauguration of the new president, Rev. G. W. Wadsworth, D.D., for some years president of Occidental College, Los Angeles, Cal. The faculty of the college has been strengthened this year by the addition of Mr. A. S. McDaniel, A.B. (Wabash), A.M. (Wisconsin), late fellow in chemistry at the University of Wisconsin, as assistant professor of physical science. A. A. Taylor, Ph.D., continues in charge of the natural sciences.

Dr. Owen L. Shinn and Dr. Walter T. Taggart have been promoted to assistant professorships in chemistry at the University of Pennsylvania, and Dr. Roger C. Wells (Harvard) has been appointed instructor in physical chemistry.

The following appointments in chemistry have recently been made of graduates of the University of Pennsylvania: R. D. Hall, Ph.D., and R. O. Smith, Ph.D., instructors at the University of Wisconsin; Jas. R. Withrow, Ph.D., instructor in the University of Illinois; Hume Bedford, Ph.D., instructor in the University of Maine; Miss Alice L. Davison, teacher in the College for Women, Columbia, S. C.

Mr. Charles J. C. Bennett, who received this year the doctor's degree in education and psychology at Columbia University, has been appointed professor of education in the Louisiana State University.

Dr. W. A. P. Martin, who has been for the past three years associated with the Viceroy Chang Chih Tung in the cause of western education, is about to assist in the formation of a great union college in Pekin, an institution which will be supported jointly by the missionary societies of the methodist, the congregational and the presbyterian churches. This enterprise is planned as a model for the guidance of the Chinese government schools.

Mr. F. S. Pinkerton has been appointed professor of applied mathematics at Cardiff.

The following appointments have been made at the University of Liverpool: Dr. A. W. Titherley, lecturer in organic chemistry; Dr. W. G. Smith, lecturer in experimental psychology; Dr. H. Bassett, assistant lecturer and demonstrator in chemistry; W. Mason, assistant lecturer in engineering; G. E. Scholes, assistant lecturer and demonstrator in engineering; C. A. Sadler, assistant demonstrator in physics.

Erratum: The review of 'The Educative Process,' by William Chandler Bagley, printed in the issue of Science for November 3, was written by Professor E. A. Kirkpatrick, State Normal School, Fitchburg, Mass. We much regret that through an error it was assigned to Professor Wilbur S. Jackman.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, NOVEMBER 24, 1905.

CONTENTS.

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE RELATION OF PHYSICAL CHEMISTRY TO PHYSICS AND CHEMISTRY.[1]

ACCORDING to the program, I have to consider the 'General Principles and Fundamental Conceptions which connect Physical Chemistry with the Related Sciences, reviewing in this Way the Development of the Science in Question itself.'

Let me begin by defining physical chemistry as the science devoted to the introduction of physical knowledge into chemistry, with the aim of being useful to the latter. On this basis I can limit my task to the relations of physical chemistry to the two sciences it unites, chemistry and physics.

But even if I limit myself to these relations, which are not the only two,[2] I wish to restrict myself yet more, in order, in the spirit of this congress, to call your attention to broad views. So I shall follow up only two lines, in answering two questions regarding two fundamental problems in chemistry: (1) What has physical chemistry done for our ideas concerning matter? (2) What has it done for our ideas concerning affinity?

The small table which I have the honor to put before you will enable us to answer these questions by appeal to the scientific development of our science, which also I have to review:

I. IDEAS CONCERNING MATTER.

1. Lavoisier, Dalton (1808).
2. Gay-Lussac, Avogadro (1811).

[1] Read before the International Congress of Arts and Science.

[2] In Chicago I devoted to this subject eight lectures, which have since appeared in the Decennial Publications under the title 'Physical Chemistry in the Service of the Sciences,' Chicago, 1903.

3. Dulong, Petit, Mitscherlich (1820).
4. Faraday (1832).
5. Bunsen, Kirchhoff (1861).
6. Periodic System (1869).
7. Pasteur (1853), Stereochemistry (1874).
8. Raoult, Arrhenius (1886–7).
9. Radioactivity (Becquerel, Curies).

II. IDEAS CONCERNING AFFINITY.

1. Berthollet, Guldberg, Waage (1867).
2. Berzelius, Helmholtz (1887).
3. Mitscherlich, Spring (1904).
4. Deville, Debray, Berthelot.
5. Thomsen, Berthelot (1865).
6. Horstmann, Gibbs, Helmholtz.

I. PHYSICAL CHEMISTRY AND OUR IDEAS CONCERNING MATTER.

The Concepts of Atoms and Molecules.—Regarded as a whole, we may say that the initial application of physical knowledge for the purpose of developing our ideas of matter consisted chiefly in the employment of physical methods and instruments in the study of the properties of matter. This stood foremost in physical chemistry in the first period of its existence.

Reviewing the history of chemistry, we must acknowledge that one of the first fundamental steps was made by the study of the physical property of weight, and the introduction of a physical instrument, the balance, for this purpose. It was, in large part, on this basis that Lavoisier was the great innovator of chemistry; and it was due solely to the following of chemical change with the balance that chemistry got its fundamental laws of constant weight and of constant and multiple proportions. These were summarized by Dalton in the fruitful though hypothetical conception of atoms, which, as is well known to you all, asserts that every element exists in the form of small unchangeable particles, identical for a given element, but differing with the latter.

As the study of weight led to the idea of atoms, so the study of another physical property, that of volume and density, led to our idea of molecules. These molecules, which might be described as constellations of atoms, were a necessity with Dalton's conception; but, in a binary compound, for instance, they might consist of two atoms or of twenty. Now, it hardly needs to be recalled that Gay-Lussac, and especially Avogadro, in following the volume relations of gases in chemical action, drew the conclusion that the molecules of gases occupy equal volumes under identical conditions. Thenceforward we had a reliable method for determining the relative weights of such molecules.

As the study of the physical properties weight and volume led to the concepts of atoms and molecules, so sharply defined that the relative weights of these entities form the fundamental constants of chemistry, so a further study of physical properties has led to broad generalizations concerning the nature of atoms and molecules, which we shall now outline.

Properties of Atoms.—As to atoms, I would call your attention to four peculiarities which seem to me of fundamental importance. First, Dulong and Petit found that the physical property called heat capacity is nearly the same for different atoms, *i. e.*, that the quantity of heat requisite to produce a given rise of temperature does not vary greatly for atomic quantities, for 7 parts of lithium and for 240 parts of uranium.

Second, Faraday, in studying the electrical conductivity of electrolytes, *e. g.*, of aqueous solutions of salts, found that the quantity of electricity which atoms can transport varies as the whole numbers,—from one in potassium to two in zinc. This fundamental property, which gives the sharpest expression to our notion of valency, was brought by Helmholtz into a very clear form by the assumption that electricity as well as matter consists of

atoms, either negative or positive, and that material atoms are able to combine with them—potassium with one of the positive kind, zinc with two, chlorine with a negative one,—and so transport them in electrolysis.

The third great step was made by the study of light, a physical property again. Bunsen and Kirchhoff found that, heated in the gaseous state, every atom emits a definite set of light waves, producing a characteristic line-spectrum which is yet the sharpest test of the kind of atoms one is dealing with, and which so became the most fruitful guide in the detection of new kinds.

The last generalization that I have to mention, and which we owe to Newlands, Mendeléeff and Lothar Meyer, includes physical properties in general, and asserts that they vary with increasing atomic weight in a periodic way. This shows itself most sharply in the atomic volume, which passes through maximum values in lithium (7), sodium (23), potassium (39), rubidium (85) and cæsium (133). A corresponding periodicity is observed in other properties, as, for example, that of combining with electrical atoms or valency, which in the said elements passes through unity. Analogous behavior is exhibited by the melting points and boiling points, which for these metals are exceptionally low.

If my program did not to a certain extent exclude quite recent investigations, confining me to a view of past history, I should like to consider one more physical property, that of radioactivity, which also seems to be a property of atoms. I can only insist on the fact that it was physical properties again, the making the air conductive for electricity, and the spectrum, which revealed radium.

Properties of Molecules.—Turning to molecules, I have three predominant generalizations to outline. The first is Mitscherlich's discovery of the fact that analogous molecular constitution corresponds to analogous outer crystalline form, to so-called isomorphism. Let me add that there is hardly any more satisfactory proof of the soundness of our concept of the internal structure of matter than, *e. g.*, the identity of the crystalline forms of the alums, which we consider to have corresponding internal structure.

A second step, to a certain extent a similar one, was made by Pasteur when he deduced disymmetry of molecular constitution from disymmetry in behavior, optically as well as crystallographically. For instance, the dextrorotatory ordinary tartaric acid and its lævorotatory antipode showed this disymmetry both in optical rotation and in the particular so-called enantiomorphous crystalline form. The molecules were supposed to have analogous structures differing from each other as the right hand from the left. As is well known, it was only later that the probable molecular structure was sharply defined, and stereochemistry was founded.

The third great step was the opening of a way to determine the molecular weights of dissolved substances. It was chiefly the application of Avogadro's law to osmotic pressures, in connection with Raoult's measurements of freezing points and vapor pressures, that opened the way. We may now assert that the liquid state is not characterized by high molecular complexity. But the great innovation, introduced by Arrhenius and immediately brought into relation with the achievement in question, was the admission of the existence of ions in electrolytes—for example, the presence of negatively charged chlorine atoms and positively charged sodium atoms in an ordinary salt solution. Once more it was a physical property, the

electrical conductivity, that led to this extremely fruitful supposition.

Conclusion.—If, after this short summary of its properties, we try to look into the nature of matter, we conclude that matter is not continuous, but that there are centers of action which seem to have an eternal existence, changing only in the place that they occupy—these are the atoms. They keep together in some way and form the molecule; how, it is pretty hard to say. The planetary constellation, with ordinary attraction and centrifugal force in equilibrium, is excluded by the consideration that at the absolute zero there is no movement at all. The repulsive force that we want might be of electrical nature; and so we come to our combination of material and electrical atoms. There is indeed something fascinating here, and when we admit for carbon that it may unite to four equally charged electrical atoms and hold them by a force of the nature of elasticity, we have at once a possible equilibrium and the tetrahedral grouping. My only difficulty is that an uncharged atom of carbon, coming into contact with the ions just described, would take away half the electric charge, and so the valency of any element might be reduced to unity. The latest supposition, that matter is built up of electricity alone, lies again beyond the scope of this address.

Let me now turn to the second part of my subject, and touch upon the problem of affinity; indeed, the action that keeps atoms together must be closely related to affinity.

II. PHYSICAL CHEMISTRY AND OUR NOTIONS CONCERNING AFFINITY.

While physical chemistry, in the first period of its development, was chiefly devoted to the study of the physical properties of matter, the second and present period is characterized by the predominant place of the problem of affinity.

This change in the general aspect of our science goes hand in hand with a different way of working: in the development of our ideas of matter, physical chemistry introduced physical methods and instruments for the study of physical properties; in the development of our ideas of affinity, physical chemistry has introduced physical principles.

Affinity Considered as Force.—The first line of thought considered affinity as a force, and in this direction it was natural to think of the Newtonian attraction as the chemical agent. So it was that Berthollet, and with far more success Guldberg and Waage, applied the laws of mass action to problems of affinity, formulating a relation still known as the mass law, according to which affinity is proportional to the weight in the unit of volume.

Now, as we all know, affinity is of a specific nature, and does not depend on weight merely; on the contrary, the least heavy elements are generally the most active. So Berzelius built up his system founded on the notion that elements have a specific electrical character, either positive or negative, and, in combining, act by electrical attraction. In this direction Helmholtz made a further step in taking into account the quantitative side. Considering the electrical charges involved in Faraday's law, he pointed out as very important that the attraction due, for instance, to the negative charge in chlorine and the positive one in hydrogen far exceeds the gravitational attraction of the masses. Yet a satisfying notion of affinity was not obtained in this way.

Affinity Measured as Work.—A second line of thought took into consideration not the force but the work that affinity represents; and it seemed a decisive step when Thomsen and Berthelot declared that the

heat developed in chemical change corresponds to the work that affinity can produce. Indeed, it was in this way that in many cases an *à priori* calculation of the heat development of a reaction permitted prediction of the direction in which the process would proceed, the direction being that of the evolution of heat. Yet, this principle, however weighty, is not absolutely reliable. The chemical actions that produce cold, as that of hydrochloric acid on sodium sulphate, are objections not to be overcome.

The step really leading to a clear and unobjectionable notion of affinity was made in the study of the so-called reversible chemical changes. This reversible character perhaps needs some explanation, easily to be provided by an illustration. Kill a chicken and prepare chicken soup; it would then be very difficult to get your chicken again. This is because preparing chicken soup is not reversible. On the contrary, let water evaporate or freeze; it will be easy to reproduce the water.

Now, at first sight, chemical change does not seem reversible; and indeed it often is not, as in the explosion of gunpowder. But investigations of Berthelot and Péan de St. Gilles on the mutual action of acids and alcohols, and those of Deville and Debray on high temperature action, which even splits up water, have shown that many chemical changes can be reversed. Indeed, we have types corresponding absolutely to evaporation, as the loss of water vapor from hydrates; and others corresponding as well to freezing and melting, as the splitting of double salts into their components at definite temperatures, *e. g.*, copper calcium acetate at 77° C. Also in analogy with physical phenomena, we have in these reversible chemical changes the possibility of equilibrium, the two chemically different forms of matter coexisting, as do water and its vapor at a maximum pressure.

Such a reversal of chemical change can take place under the influence of temperature, of electricity, of light, of pressure. And the easiest way to arrive at a measure of affinity is presented in the last case, as was foreseen by Mitscherlich. Let us take gypsum as an example. Burnt commercial gypsum, mixed with water, will combine with the water. We know that this chemical change can produce pressure, and that it may be prevented by sufficient pressure and be reversed by it, as Spring succeeded in pressing out sulphuric acid from sodium bisulphate. And it is possible in such cases exactly to determine the limiting pressure, such that a higher one presses out the sulphuric acid while a lower one is overpowered by the affinity action. If the chemical change takes place under a pressure only slightly less than that which would prevent it, thus practically taking place under the limiting pressure, we get out of affinity the greatest quantity of work that it can possibly produce; and this quantity is the same whatever the nature of the opposing action, be it electricity, light, or anything else. Therefore, in this maximum work we have a sound measure of affinity.

It was a very happy coincidence indeed, that this conception of affinity made possible the application of a physical principle known as the second law of thermodynamics. This principle may be formulated in different ways. For my purpose let me say that it limits the possibility of natural processes to the occurrence of those in which a difference of intensity is diminished. If there is a difference of pressure in two parts of a gas, a movement will occur producing equality; if there is a difference of temperature, heat will be transported so as to produce equality once more. It is curious that such simple neces-

sities, which we all feel as such, can be converted into far-reaching sharply formulated equations, as was done by Carnot and Clausius. These principles were first applied in chemistry by Horstmann. Then, by successive application to chemical problems by Massieu, Gibbs, Helmholtz and others, was won a system of relations touching the problem of affinity, to which I can give only brief attention:

1. Affinity may be defined as the maximum quantity of work that a chemical change can produce. Equilibrium ensues when this quantity is zero.

2. The mass law can be obtained in a well-founded and somewhat modified form, restricted to dilute gases and solutions.

3. The Thomsen-Berthelot principle assumes a modified form in the rule that a fall of temperature induces the formation of that which develops heat. It is, for instance, in accordance with this rule that at ordinary temperatures water is stable in comparison with detonating gas, and that at high temperatures this relation is reversed, as it was found by Deville to be.

4. Lastly, we have the phase rule, indicating, for example, in what cases chemical phenomena will be comparable with melting and freezing, and in what cases they will be comparable with evaporation and condensation.

Most curious of all, we can treat problems of affinity in an absolutely trustworthy way, so that our calculations furnish a check upon experiment, without admitting anything concerning the nature of affinity or of the matter wherein the affinity is supposed to reside.

J. H. VAN 'T HOFF.

THE PROBLEM OF RENAL FUNCTION.[1]

IN my first lecture I touched upon a series of physiological problems that have been elucidated in a pharmacological way. I treated these problems in a merely cursory manner and did not enter upon details of the various investigations. Permit me to-day to discuss more fully a problem which has for a long time claimed my attention and which has for many years been a topic of research in my laboratory, namely, the problem of renal function.

As is well known, there are two leading and opposing theories on the nature of urinary secretion. According to one of these theories, which was developed most fully by Heidenhain, we have to deal with a true secretory process by which water and perhaps the salts pass through the glomerulus, whereas the specific constituents of the urine are liberated from the tubules so that the sum of both secretions is represented by the outflowing urine. According to the other hypothesis, which was first proposed by Ludwig and subsequently modified (in a biological sense) by his successors, there goes on in the kidney, side by side with the glomerular activity, dependent essentially on the mechanical conditions of the circulation, and independently also on the secretion of certain urinary constituents, a process of resorption in the urinary tubules. Through this resorption the slightly concentrated secretion of the glomerulus, corresponding to the water of the blood, undergoes concentration to a point characteristic of the urine.

The output of urine is chiefly conditioned on the largely physical excretory process, which, on account of its dependence on the blood flow, and the blood pressure in the kidneys, one is justified in regarding as a kind of filtration or transudation. On the other hand, the resorption of water through the tubules is not directly dependent on the circulation of the blood. That is, it is in nowise proportional to the abundance of

[1] Being the second of the Herter Lectures delivered at the Johns Hopkins Medical School.

the glomerular filtration. It would be more nearly correct to say that this process is inversely proportional to the filtration. There is, therefore, the more abundant and unconcentrated urine when the blood flow is more abundant, and, on the contrary, a more scanty and concentrated urine when the blood flow is scanty.

The Ludwig theory, as you are aware, is based chiefly on the directly evident dependence of the urinary secretion on the blood stream through the kidneys and on the blood pressure, and in fact this connection is a striking one. I will remind you of the experiments of Goll, which were conducted as long ago as the year 1854, in which the tension in the vessels was lowered by vagus irritation or by bleeding, or elevated by clamping the large vessels of the extremities, in which the volume of the urine rose and fell according to the increased or diminished flow of blood through the kidneys.

Against the whole theory of Ludwig, supported as it was on many other facts and arguments, Heidenhain brought a series of objections, of which the following was especially impressive. If the human blood holds about one tenth of one per cent. of urea and if it be estimated that the daily excretion averages about 30 grams of urea, it would follow that on the smallest estimate 30 liters of fluid must filter through the kidneys in twenty-four hours, for which about 28 liters of water must be reabsorbed. But if, according to the calculation of Heidenhain, not more than 130 litres of blood pass through the kidneys in the course of a day, it follows that according to Ludwig's view about one quarter of this volume filters out—a condition which would lead to a wholly impossible concentration of the blood in the glomerulus. In addition to this objection was urged the uneconomical work involved in the resorption through the urinary tubules of such great quantities of superfluous water. But we now know through the careful investigations of Tigerstedt that there flows through the kidneys during a very moderate diuresis in one minute a quantity of blood corresponding to 80–100 per cent. of their weight, or, in other words, since the human kidneys weigh about 300 grams, these organs are traversed by about 240–300 grams of blood in a minute, equivalent to 345–430 liters in twenty-four hours. Thus it is only about one twelfth to one fourteenth of the volume of blood and not one fourth of its volume, that is expressed. And so far as the chemical work of resorption is concerned, it must be remembered that the work of excreting 30 grams of urea through the elective action of the tubular epithelium from blood holding only 0.1 per cent. of urea must be exactly as great as the corresponding work of resorption by the same cells—in order to concentrate a 0.1 per cent. blood filtrate to 1.5 per cent. of urea through the resorption of water. Now Heidenhain endeavored to demonstrate the specific secretory function of the epithelia by means of injection of coloring matters. He injected into the veins of a rabbit a definite quantity of sodium sulphindigotate and removed the kidneys after a certain period of time, injected the vessels with alcohol and examined the structures histologically. He then found under certain conditions that the glomeruli were wholly free from coloring matter; the epithelia of the tubules, on the other hand, were colored. And he concluded from this that the dye was not secreted from the glomerulus but was secreted by the tubules. And from these observations Heidenhain made the inference that the epithelia of the tubules secrete also other constituents of the urine. These experiments are so well known that

I do not need to enter more fully upon them; what concerns us here is that they secured a wide acceptance for the Heidenhain theory. But since the pharmacological study of glandular secretion as compared with renal activity has shown that these forms of cellular function are different and even opposed to one another in certain respects, and since the behavior of certain pharmacological agents is difficult to harmonize with the Heidenhain view and easier to bring into accord with the theory of Ludwig, a number of pharmacological studies have been undertaken with a view to testing the validity of the Ludwig theory. If, as Heidenhain maintained, the coloration of the kidney is an indication and measure of its normal secretory activity, it might be expected that by means of experimentally increased diuresis this coloration would show corresponding alterations, that is to say, coloration would be intensified in the tubules. With this idea in mind Sobieranski, about ten years ago, began a new study of this subject in my laboratory by means of color injections, carried out according to the Heidenhain method. His results on normal animals led him to the conclusion that dyes were not excreted by the convoluted tubules, as Heidenhain thought from his findings, but in company with the water stream through the glomeruli, whence the dye passed into the tubules and was absorbed into the epithelium, coloring their nuclei. Through the simultaneous reabsorption of water by the tubules, the dye-stuff solution becomes more and more concentrated so that it (the dye) under certain conditions is bound to be separated in a crystalline state in the epithelium.

This had already been shown to be the case by experiments with sodium sulphindigotate, but still more clearly by means of experiments with carmine, a dye which is better adapted to this kind of experimentation because it does not undergo reduction (with loss of color) in the tissues. Even more surprising and striking were the results obtained on diuresis under the influence of caffeine, sodium nitrate or urea. Here the tubules were found to be very little or not at all colored. It was thus shown that an increase in the secretion of the dye through the tubular epithelium, which the hypothesis of Heidenhain calls for, under these circumstances did not exist. On the other hand, the process becomes intelligible through the explanation of Sobieranski. These diuretics give rise to diuresis by inhibiting the absorption of water from the urinary tubules, and at the same time prevent the absorption of the coloring matter by the tubular structures. Against this interpretation of Sobieranski's findings it is possible to offer certain objections, the validity of which we have recognized from the beginning. The experiments of Sobieranski can be regarded as corroborative evidence of the resorption function of the urinary tubules, but not as positive proof of this function.

One may approach the subject, also, from an entirely different side. If the process of separating water from the blood in the glomeruli is not an elective secretory process, as in other glands, but is in reality a process analogous to filtration, that is to say, is essentially dependent on physicochemical conditions, then one would expect, as Tammann has already shown, that together with the free water of the blood (not held by the blood colloids) the dissolved crystalloid constituents, like urea and salts, would simultaneously filter through; in other words, that with increased separation of water these bodies would also be excreted in increased amounts. On the other hand, the colloids and other substances similarly held in the

blood, which can not transude or filter through the normal glomeruli are not driven through with the water flow. They must rather be secreted through specific cell activity and quite independently of all mechanical filtration.

Indeed, we have known for a long time, from purely clinical observations, that some urinary constituents, like urea and sodium chloride, are excreted almost proportionately to the volume of the urine; and that others, on the contrary, like uric acid and phosphoric acid, are not influenced by the quantity of urine. In order to examine this problem in a quantitative way, a series of observations has been made by my assistant and collaborator, Otto Loewi. These experiments were made on dogs and rabbits in the following manner: The normal excretion of uric acid, urea and phosphoric acid was studied during a preliminary period of several hours. In still other cases the excretion of sugar was studied—indeed, not merely in diabetes following pancreas extirpation, but also after phlorhizin administration and intravenous injections of sugar. Then the secretion of urine was increased experimentally through free administration of water or by means of diuretics, such as sodium nitrate or caffeine, and during the diuresis so induced the above-mentioned constituents were quantitatively determined. Finally similar observations were made during and after the period following the cessation of the diuresis. The outcome was that the excretion of urea and of chlorides ran regularly parallel with the volume of the urine. On the other hand, there was never observed any parallelism between the excretion of water, on the one hand, and the increased amount of uric acid and phosphoric acid normally produced in the organism, on the other. I specially emphasize the phosphoric acid normally produced in the organism, for any phosphoric acid introduced as a salt into the circulation showed a different behavior. Such introduced salts followed the same law of excretion as the chloride and urea; and this same general law held true in the case of sugar.

The blood, as is well known, always contains sugar, but in a combined form, so that the sugar under normal conditions is not excreted by the kidneys. But after pancreas extirpation or after an intravenous infusion of sugar in normal animals, the sugar content of the blood rises above the normal; the greater part of it can not exist in combination in the blood but is free and, like urea and other crystalloids, is excreted by the urine. And it appears from Loewi's experiments on diuresis that in such pancreatic or infusion diabetes, the quantity of excreted sugar was always proportional to the volume of urine excreted. In phlorhizin diabetes, on the other hand, the behavior was entirely different. As you are aware, there occurs no hyperglycaemia in phlorhizin glycosuria. There is no increase of free sugar in the blood, but the normally combined sugar is liberated from its combination and excreted from the kidneys. And this specific cellular sugar excretion was shown to be quite independent of the filtration of fluid through the glomeruli, that is independent of the amount of diuresis. From this it seems to follow, in fact, that the substances which exist free in the blood pass out mechanically with the water; while other bodies, such as uric acid, phosphoric acid, phlorhizin-sugar, and probably the urinary pigments, are excreted from the kidney by special secretory activity. It is not necessary that a substance exist in a crystalline state in order that it be secreted by mechanical filtration through the glomeruli; it may equally well be a colloid, provided,

however, that it is not combined with the blood tissue. It has long been known that dissolved hemoglobin and injected albumin passed through the kidney into the urine. It is also shown by direct microscopical investigation that these bodies pass through the glomeruli. And, as in the case of urea and salts, this excretion of proteids through the glomeruli has been shown by experiments by Dr. Schmidt and Dr. Loewi in my laboratory to be a mechanical filtration.

This specific excretion of uric acid, etc., can not be increased by any of the known diuretics. The action of diuretics, therefore, can surely not be explained by the supposition that there is a stimulation of the secretory activity of the kidneys. And, moreover, a specific renal secretion is something quite different from the secretory activity of the glands, for the typical glandular poisons, like pilocarpine, not merely are without influence on diuresis in general, but have no effect whatever on the excretion of uric acid, phosphoric acid, etc. If, then, the filtration of the watery constituents of the blood is highly probable, it follows that as a means of saving water there must be a compensatory resorption in the tubules analogous to the process of resorption from the alimentary canal. In the case of the intestinal tract large quantities of fluid are secreted from the mouth, stomach and small intestines, even to the amount of several liters in twenty-four hours, which is later reabsorbed in the large intestine, especially in the colon, resulting in the semisolid fæces. And a similar process may be conceived to go on in the kidneys.

We have undertaken to determine whether this conception is correct. If under normal conditions such a process of concentration occurs in the tubules, one would expect a diarrhœa (that is, a flow of unconcentrated fluid from the blood) to result from elimination of or injury to these parts, just as there results a flow of watery fæces if the colon be removed or its cells paralyzed by poisons, or if the contents of the intestines are rendered incapable of absorption by the addition of certain salts. With this thought in mind Ribbert long ago conducted experiments involving the removal of the medulla of the kidney, as a result of which he did, in fact, observe an increased secretion of a very dilute urine in rabbits. Similar experiments were undertaken by Dr. Hausmann and myself three years ago, by means of a somewhat modified operative technique and especially with the aid of quantitative analysis of the urine. In rabbits from which the right kidney had been removed previous to operation on the left kidney, we found the excretion of urine increased three or four times, just as did Ribbert, and observed a change from a concentrated mucus-like urine before the operation to a light-colored watery urine of low specific gravity after the operation. Quantitative analysis further gave the noteworthy result that whatever might be the normal content of chlorides and urea, after the operation the content always approximated that of the blood serum; for example, if the normal content of sodium chloride in a diet poor in this salt averaged 0.1 per cent. or in a diet rich in sodium chloride approximated 2–3 per cent., after the operation there would result in each case a percentage of sodium chloride which varied within the narrow limits of 0.6 to 0.8 per cent. This result seemed to speak strongly for the resorption theory. The resorption activity of the kidney may be influenced by pharmacological means as well as by removal of the uriniferous tubules. One would expect, as in the case of the intestines, that salts would check resorption from the tubules, and, further, that as in the case of the intestines, the

bibasic would act more strongly than the monobasic salts. Comparative study of the action of Glauber salt and common salt injected into the blood vessels, made by Dr. Halsey, yielded the expected results. Results similar to these unpublished ones, have been obtained by Gottlieb and Magnus of Heidelberg, and especially by Cushny, of Ann Arbor. The isosmotic solution of Glauber salts possessed a much more strongly diuretic action than common salt. From these experiments we may conclude with Cushny that the salts prevent water resorption from the tubules and set up a kind of diarrhæa in proportion to their power of withdrawing water, and that hence in accordance with the Ludwig theory, we must assume that a resorption of water occurs under normal conditions. The matter is, however, not quite so simple, for the salts, owing to their ability to withdraw water, also withdraw water from the tissues into the blood, thereby increasing the filtration stream through the glomeruli. Cushny further showed that fixed constituents, like sodium chloride, may be reabsorbed, as in the case of the intestines, by the epithelia of the tubules, that the difficultly diffusible Glauber salt was only slightly and slowly reabsorbed, and that finally urea is apparently not reabsorbed at all. A further striking example of such a renal diarrhœa, as I am inclined to call it, has been brought forward by Loewi. As I have already stated, every diuresis dependent on increased glomerulus filtration occasions also an increased excretion of sodium chloride and urea. If one poisons an animal with phlorhizin there also occurs an increased diuresis. This phlorhizin diuresis, as Brodie showed, appears to be wholly independent, in general, of the circulation and especially of the circulation through the kidney. And, what particularly interests us here, this diuresis is not dependent on the filtration of water through the glomeruli, for, according to Loewi's analysis the chlorides and urea were not excreted in increased amount, as is the case in all the other forms of diuresis. The phlorhizin diuresis must be regarded, therefore, as a pure tubular diarrhœa, brought about by the sugar excreted in the tubules of the kidney itself and there hindering the resorption of water by means of its water-attracting properties.

We have, therefore, in many instances two closely connected processes which constitute the basis of increased diuresis, the interference with resorption from the tubules, and the increased filtration through the glomeruli, the latter being probably the more important factor. The question arises what are the conditions that determine the operation of these factors? It may be that to a slight extent the diminished viscosity of the blood or, more properly, the degree of saturation of the colloids of the blood with water are here concerned. We know that in thirsting animals the kidney secretion can not be increased in any way; we have, therefore, no quantitative conception of the extent of this influence. On the other hand, we know of one factor which is of determining significance for the process of filtration. This is the blood flow through the kidney. It was long ago shown by Roy that as a rule every diuresis is associated with an increase in the volume of the kidney, that is, sets in simultaneously with an increased blood flow, and the experiments of Roy have been repeatedly carried out with essentially the same results by numerous investigators, and especially by Gottlieb and Magnus and by Starling and Bayliss. Still it appeared from time to time that there were exceptions in which increased diuresis occurred in association with an unchanged volume or scarcely perceptible increase in the volume of the kid-

ney. Gottlieb and Magnus, therefore, felt justified in concluding that the increased blood flow through the kidney is not the primary and determining condition for increased diuresis, but rather a regular and not essential associated phenomenon. My collaborator, Professor Loewi, also carried on a large number of experiments in this direction. He, too, found that in certain cases the oncometer showed no increase in the volume of the kidney, notwithstanding an increase in diuresis. We further undertook to determine whether diuresis occurred under the influence of diuretic agents, like caffeine and salts, even when the volume of the kidney was fixed so that an increased blood flow is presumably prevented. For this purpose the left kidney of the rabbit in a relatively quiescent and relatively anemic condition was encased in plaster of Paris with the exception of the hilus only, so that an increase in the volume of the kidney was wholly excluded. The surprising result was obtained that even in the case of such rigidly enclosed kidneys, diuretics like caffeine and salts were able to induce an abundant diuresis. Hence it seemed to be actually true that an increased filtration may be induced without any increase in the blood flow through the kidneys. But more careful investigations showed that the volume of the kidney is by no means a certain measure of the blood flow through this organ, but that the volume of the kidney and the blood flow through it may be independent. For by inspection of the outflowing venous blood it could be seen that, notwithstanding the rigid limitation in the volume of the kidney, the flow of blood through the organ was always enhanced during diuresis. While the blood which flowed through the renal vein was dark previous to the diuresis, the stream took on a light, arterial color under the influence of caffeine and salts. The mere fact, therefore, that the kidney does not increase in size in some cases of caffeine diuresis is no proof that the process of diuresis does not depend on an increased flow of blood through the kidney, and one may say that an increased renal blood flow is a regular and essential condition of diuresis from salts, urea and caffeine—a condition wholly sufficient, in itself, to explain the diuresis. It is not possible to say with certainty whether in the case of caffeine diuresis there is also a diminished resorption of fluid through the urinary tubules, as Sobieranski's experiments appeared to show. Another important fact was brought out by Loewi in this connection; we know that every hydremia, whether induced by the administration of water or by the withdrawal of water from the tissues by means of salts intravenously injected, gives rise to an increased diuresis, without any increase in the general blood pressure or the work of the heart. What is the origin of such a diuresis? Loewi found that every hydremia, whatever may be its origin, acts upon the vessels of the kidney as a specific excitant, in that it dilates the vessels and thus causes an increased glomerular filtration. Thus we have obtained an explanation for the increased secretion of urine arising from all forms of hydremia, from the drinking of water, and from the withdrawal of water from the tissues, in consequence of the action of the diuretic salts. Hence we may say that all the observations that have come to us by physiological and pharmacological methods harmonize with the conception that the water of the blood and the free crystalloids therein dissolved are liberated from the glomeruli by the process of filtration or perhaps a process better described as transudation, and, further, that the urinary tubules reabsorb, by means of their epithelial cells, not only water, but also, in

cases of salt poverty, sodium chloride as well (these being materials which the organism can not afford to lose), while at the same time these epithelial cells, like those of the intestines, have also to perform the duty of excreting the combined substances of the blood by means of their specific secretory activity.

Diuresis, therefore, represents the fusion of two principal processes—one concerning the gomeruli, which is in its main features mechanical in its nature; the other pertaining to the urinary tubules, which is not yet explicable on any physico-chemical hypothesis. The process of resorption from the urinary tubules has a distinctly biological, that is, teleological character; water and salt are only reabsorbed when the organism does not possess these in excess. If one administers an abundance of water, the urine acquires a highly watery character, while after the administration of an abundance of sodium chloride there is a failure on the part of the tubules to reabsorb salt, as Loewi has shown. The process of reabsorption adapts itself, therefore, to the requirements of the organism.

Although I believe that the theory of renal function which I have here presented is the one which has the best experimental foundation, I readily concede that it leaves many facts still unexplained. For example, it is difficult by means of this hypothesis to explain the constitution of the urine in diabetes insipidus as well as the complete retention of chlorine under certain conditions, and I fancy that we shall have to suppose, as Cushny has done, that there is some kind of combination of sodium chloride with the blood tissue which hinders its filtration. The theory of diuresis and the action of diuretic drugs further possesses a practical interest. If, for example, it be true that caffeine acts diuretically through local specific dilation and not through irritation of the secretory cells, as was formerly supposed, then, as Loewi thinks, we are justified in its administration during long periods in the course of nephritis in which, in many instances, the vessels of the kidneys are abnormally contracted. And there is some reason to believe that the vasodilator action of the caffeine not merely induces an increased diuresis but exerts a favorable influence upon the pathological condition of the kidney itself.

In conclusion, I desire to express my appreciation of the courteous attention you have accorded me. Hans Meyer.

THE EVOLUTION OF SPECIES THROUGH CLIMATIC CONDITIONS.

In a recent article in Science,[1] entitled 'The Origin of Species through Isolation,' President David Starr Jordan has presented much evidence bearing upon the influence of geographical isolation in the formation of species and races of animals and plants. He dwells especially upon the agency of barriers in interrupting the flow of life and isolating groups of individuals of a species, which groups of individuals, either with or without material change in the conditions of existence, 'may become in time an entirely distinct species if the barrier is really insurmountable.' This is impliedly recognized as only one of various influences that tend to modify species, but in this connection, in marshalling the evidence in favor of the proposition of the origin of species through isolation, hardly any reference is made to the part played by other agencies in the evolution of new forms. In this way, rather undue importance is given to a single and well-recognized factor in the problem of evolution. The purpose of the present paper is not to

[1] N. S., Vol. XXII., No. 566, November 3, 1905, pp. 545–562.

question or controvert any of the evidence, or in any way to belittle the principle of evolution by isolation, but to bring forward other well-known facts that bear on the problem of evolution through environment unassisted by isolation or obvious physical barriers.

Says President Jordan, in his opening paragraph:

It is now nearly forty years since Moritz Wagner (1868) first made it clear that geographical isolation (räumliche Sonderung) was a factor or condition in the formation of every species, race or tribe of animal or plant we know on the face of the earth. This conclusion is accepted as almost self-evident by every competent student of species or of the geographical distribution of species. But to those who approach the subject of evolution from some other side the principles set forth by Wagner seem less clear. They have never been confuted, scarcely even attacked, so far as the present writer remembers, but in the literature of evolution of the present day they have been almost universally ignored. Nowadays much of our discussion turns on the question of whether or not minute favorable variations would enable their possessors little by little to gain on the parent stock, so that a new species would be established side by side with the old, or on whether a wide fluctuation or mutation would give rise to a new species which would hold its own in competition with its parent. In theory, either of these conditions might exist. In fact, both of them are virtually unknown. In nature a closely related distinct species is not often quite side by side with the old. It is simply next to it, geographically or geologically speaking, and the degree of distinction almost always bears a relation to the importance or the permanence of the barrier separating the supposed new stock from the parent stock.

With the above I am in hearty accord, except with the declaration that geographical isolation is a 'factor or condition in the formation of every species, race or tribe of animal or plant * * * on the face of the earth'; especially if the isolation here meant implies a physical barrier, 'geographical or climatic,' to the continuous range of closely allied forms, as the general context seems clearly to involve. That isolation is an important factor no intelligent biologist will be disposed to deny; that it is not the only important factor, or, as regards incipient species, the chief one involved there is ample evidence, well-known to a large number of present-day investigators.

President Jordan, however, appears to have mainly in mind species, or fully segregated forms, rather than incipient species, or intergrading geographic phases; as when he states, as 'practically a universal rule': "A barrier which prevents the intermingling of members of a species will with time alter the relative characters of the groups of individuals thus separated. These groups of individuals are incipient species and each may become in time an entirely distinct species if the barrier is really insurmountable."

In illustration of his theme, the author cites examples of mammals, birds, fishes and mollusks, which serve very well to illustrate the points at issue; except that incipient species, as well as fully segregated forms, are claimed to owe their existence to barriers, either geographic or climatic, which is not generally the case, taking the term 'barrier' in its commonly accepted sense.

Doubtless President Jordan well knows that among birds and mammals, and especially among the former, many wholly distinct congeneric species, or forms that are known not to intergrade, are often much more nearly alike, structurally and in color and size, than are the extremes in many groups of forms that are known to intergrade completely through geographically intervening forms, as notably in the song sparrow (*Melospiza cinerea*) group; and that many other conspecific groups of wide distribution show nearly parallel variations, as the horned larks, and, to a lesser

extent, many species of woodpeckers, jays, the bob-whites, some of the pipilos, juncos, wrens, titmice, etc. As to exploit all of these cases would require a good-sized volume, only two or three can be taken for illustration in the present connection.

In the first place, to facilitate treatment, certain general well-known laws of climatic or geographic variation may be recalled, which are of so nearly universal application that the exceptions, generally easily explainable, may be ignored. First, in relation to size. In the northern hemisphere, in nearly all types of both birds and mammals of obviously northern origin, there is a gradual decrease in general size from the north southward in the representatives of a conspecific group, most marked, in the case of birds, in non-migratory, or only partly migratory, species, the most southern representatives of such groups being from one fifth to one third or more smaller than the most northern representatives of the same groups. At the same time, but less generally, there is a relative increase in certain peripheral parts, as the length of the tail, the thickness or length of the bill (according to its form) in birds, and often the ear, tail and feet in mammals.[2]

Secondly, and coincidently with the decrease in size southward, is a change in coloration, which may be described in general terms as a restriction in area of all white markings and a corresponding increase in the area of the dark markings, together with, generally speaking, an increase in the intensity of color in markings or areas of other tints than black or white, as yellows, greens, browns, etc., and also in iridescence, in birds of metallic tints. The birds of latitudinally extended breeding ranges in eastern North America rarely present exceptions to these rules; and many

[2] As already intimated, there are some exceptions to the rule of decrease in size southward, which are covered by the following propositions, first formally propounded in 1876 (*Bull. Geol. and Geogr. Surv. Territories*, Vol. II., No. 4, July, 1876, p. 310) in relation primarily to mammals and later (*Bull. Nutt. Orn. Club*, Vol. III., April, 1883, pp. 80–82) restated with more direct reference to birds, as follows:

"(1) *The maximum physical development of the individual is attained where the conditions of environment are most favorable to the life of the species.* Species being primarily limited in their distribution by climatic conditions, their representatives living at or near either of their respective latitudinal boundaries are more or less unfavorably affected by the influences that finally limit the range of the species. * * * Different species being constitutionally fitted for different climatic conditions, surroundings favorable to one may be very unfavorable to others, even of the same family or genus. Hence:

"(2) *The largest species of a group* (genus, subfamily, or family, as the case may be) *are found where the group to which they severally belong reaches its highest development, or where it has what may be termed its center of distribution.* In other words, species of a given group attain their maximum size where the conditions of existence for the group in question are the most favorable, just as the largest representatives of a species are found where the conditions are most favorable for the existence of the species.

"(3) *The most 'typical' or most generalized representatives of a group are found also near its center of distribution, out-lying forms being generally more or less 'aberrant' or specialized.* Thus the Cervidæ, though nearly cosmopolitan in their distribution, attain their greatest development, both as respects the *size* and the *number* of the species, in the temperate portions of the northern hemisphere. The tropical species of this group are the smallest of its representatives. Those of the temperate and cold-temperate regions are the largest, where, too, the species are the most numerous. Most of the species of this family also have a wide geographical range, and their representatives respectively present great differences in size with locality, namely, a very marked decrease in size to the southward. The possession of large, branching, deciduous antlers forms one of the marked features of the family. These appendages attain their greatest development in the northern species, the tropical forms having them reduced almost to mere spikes, which in some species never pass beyond a rudimentary state. * * *"

of the mammals of the same region exhibit perfectly parallel variations. Nor are these rules restricted to eastern North America, but prevail throughout the northern hemisphere, and also in the southern hemisphere, with, however, the conditions reversed, the increase in size and intensity of colors being from the south northward. High mountains in low latitudes represent, in respect to these phenomena, the higher latitudes nearer sea-level.

It is equally well known that, in continentally dispersed groups, pallid tints accompany desert areas and arid conditions of climate, and that increase in depth of color, particularly in gray, brown and olive tints, is an inseparable accompaniment of regions of heavy rainfall and a moist climate, so familiarly illustrated in the northwest coast region of North America. Furthermore, there are various other areas in the world where the animal inhabitants are collectively characterized by some special feature of coloration, as excessive lightness of color—hoariness, or increase in area of light or white markings in eastern Siberia, or redness or blackness of coloration in parts of Africa, etc. In other words, regional areas of peculiar climatic conditions impress upon their animal inhabitants a certain distinctive phase of coloration, developing in some instances wholly new specific types, in others merely forms that intergrade with others of the immediately adjoining districts.

To return now to our starting point in eastern North America, the variation in size from the north southward is as gradual and continuous as the transition in climatic conditions; there are no barriers, in the ordinary sense, and no abrupt transitions. In conspecific groups the phase inhabiting Canada or the northern border of the United States, in species of wide breeding range, differs more from the phase inhabiting southern Florida and the Gulf coast than do many congeneric species known to be completely distinct; and were these phases isolated by a wide geographic interval they would have to be recognized in nomenclature as distinct species. It would also be the same if they were found living together, the differences between them are so marked. In reality, however, these very distinct phases are merely the extremes of a single continuous intergrading series or unbroken sequence of individuals of one and the same species.

In passing westward from the Atlantic seaboard to and across the arid interior of the continent, and thence to the Pacific coast and northward to Alaska, other forms of the same conspecific groups may come into view, so distinct from their eastern representatives and from each other, that many of them were originally described as distinct species, and for many years were so recognized, till the accumulation of material from many intermediate points showed them to be connected by insensible gradations over the intermediate regions, and that their true status was that of incipient species, or merely geographic forms, distinct enough when birds of distant and limited areas are compared, but inseparable when those of intermediate regions are taken into account. There are also, in these cases, no barriers beyond the gradual climatic transition from one area to another. This, at some points, owing to topographic conditions, may be abrupt, but in general is too diffused to prevent the continuous spread of the species.

In illustration of these points, we may take the downy and hairy woodpeckers (*Dryobates pubescens* and *D. villosus*), both species of continental distribution, and each with its half dozen or more commonly recognized subspecies, varying enormously in color and in size when those of

eastern North America are compared with each other, or either of these with the Rocky Mountain forms, and these again with the northwest coast and southern California birds.

The eastern flickers (*Colaptes auratus*), the western flickers (*C. cafer*), and the eastern pileated woodpecker (*Ceophlœus pileatus*), have also been divided into subspecies, mainly on the difference in size between the northern and southern representatives of the species. The bob-white (*Colinus virginianus*) has in the east its northern and southern forms, differing markedly in size and coloration, with another pallid form in Texas, which passes into a group of very diverse forms in different parts of Mexico, some of them having black instead of white throats, uniform chestnut instead of barred black and white underparts, and others with various other combinations of characters, yet all retaining their characteristic *bob-white* call, and so blending with each other and the northern forms as to be found to be specifically inseparable, though they have usually been accorded the status of species.

The horned larks (*Otocoris alpestris* group), ranging from the Arctic regions to northern South America, and embracing nearly a score of forms, some of them extremely diverse, are found to completely intergrade, though the various forms have special breeding areas, and have obviously attained their differentiations under the most diverse climatic conditions. Yet they are separated by no appreciable barriers, and contiguous forms completely intergrade, forming an unbroken chain from one extreme of the series to the other.

The almost hackneyed case (at least to ornithologists) of the song sparrows (*Melospiza cinerea* group), nearly continental in dispersal and differentiated into about twenty recognized forms, may well close this series of illustrations. Many of the forms of this group are so different that, when compared without the connecting links, they seem like remotely related species, almost different enough for subgeneric separation. Between the great gray song sparrow of the Aleutian Islands and the little song sparrow (*pusillula*) of the San Francisco salt marshes the difference in size is enormous, the length of the wing being 85 mm. in the Alaska bird and 56 mm. in the San Francisco bird, the northern bird having probably more than twice the bulk of the southern one. Between them are some eight Pacific coast forms, by means of which there is continuous gradation between these extremes. Between the desert forms of the interior and the coast form at Sitka, there is much less difference in size, but the former is a pale gray bird, while the latter is deep intense rufous.

The recognized Pacific coast forms, from Lower California to the Aleutian Islands, excluding several insular phases, are nine in number, between which there is no abrupt barrier, either climatic or geographic, and consequently we find the successive and gradual mergence of all; but if a few of the links were dropped out, the remaining forms might readily be taken for distinct, fully segregated species, so much do they mutually differ.

Almost numberless similar illustrations might be cited among North American mammals. In general, the geographic ranges of conspecific groups in mammals are less extended, but they are of sufficiently wide range to include a great variety of environmental conditions, which result in marked modifications of size, color and structure.

Indeed, mammals being sedentary, they are even more susceptible to climatic modification than birds. Some of the more

widely dispersed species of squirrels, spermophiles, voles, field rats and mice, hares, gophers, pouched rats and mice, deer, shrews, moles and bats, afford admirable illustrations of differentiation without isolation. To cite a single notable case, the Virginia deer ranges over eastern North America from New England and southern Canada to Central America, varying greatly but gradually, in size and other features, till in the southern forms the size is only about one half of that of the northern, with disproportionately reduced antlers.

Variations of this nature, however striking, can not be due to isolation, for in the cases here in view there is no isolation, but continuous distribution, and consequently complete intergradation. The amount of differentiation, between the more extreme phases in various directions, is great enough, were these several forms isolated, or separated by geographic intervals, to warrant their recognition as well-marked species. All that is requisite to constitute them species is the extinction, through some physical cataclysm or other cause, of the connecting links, over portions of the intermediate areas by which even the extremest phases are at present connected. Doubtless in the past many species, and perhaps genera, have had their origin in the dismemberment of such groups of incipient species, through violent physical changes in the distribution area of widely dispersed specific types.

At present these connecting links between the leading phases of highly diversified conspecific groups are a nuisance and a stumbling block to the systematist in labeling collections, since between each properly namable form there is an area, more or less extended, where none of the forms are typically represented, but which is occupied by troublesome intergrades, approaching one form, usually, more than another, and in various degrees. These intergrades, furthermore, offer a temptation to aspiring young naturalists to give them a name, thus 'bridging the difficulty by doubling it.' If these areas of intergradation could be transformed into areas of isolation many problems in nomenclature and much trouble in identifying specimens would be eliminated.

The facts already set forth explain why two or more subspecies are never found in the same breeding area—a proposition discussed at some length in the paper here under consideration. They also show why insular forms, if separated somewhat remotely from the parent stock, assume the character of species rather than subspecies, and owe their existence to isolation. But insular forms exhibit various degrees of distinctness from the parent stock, depending upon the completeness and duration of the period of isolation. Theoretically there can be no intergradation between insular forms, particularly in land mammals—not so clearly in the case of birds, with their exceptional powers of locomotion; but in the case of forms inhabiting islands but little removed from a neighboring mainland, the environing conditions may be so similar that not time enough has elapsed to develop a well-marked type through the action of isolation, in which case the normal range of individual variation in the insular and the stock forms may be sufficient to cause an overlapping of the characters through occasional individual aberration. This might be mistaken for actual intergradation, while it is in fact merely an overlapping through individual variation. To this condition is probably due the recent tendency to give slightly differentiated insular forms the rank of subspecies rather than that of full species, to which theoretically they should be entitled.

I have long been a believer, in common

with many of my fellow-systematists, in the evolution of species and races by environment, which, of course, includes evolution by isolation. This seems far more rational than evolution by natural selection, as this process was originally defined. But since the inefficiency of natural selection, pure and simple, to produce the results formerly attributed to it became evident the significance of the term has been expanded to embrace evolution through climatic influences, including also the factor of isolation. The inefficiency of natural selection, as originally defined, in the evolution of species and races was the subject of frequent comment by the present writer in various papers published some thirty years ago, in opposition to which was urged the direct action of environment in the origination of incipient species. The discussion was eventually summarized in a paper published in 1877, entitled 'The Influence of Physical Conditions in the Genesis of Species.' This paper, of some thirty-three pages, appeared in a short-lived and not widely known magazine,[3] and thus doubtless escaped the attention of many investigators interested in such problems. The facts of geographic variation were here presented at some length.

In discussing Darwin's statement[4] regarding the method of the action of natural selection, namely: 'I believe that natural selection generally acts slowly in effecting changes, *at long intervals of time, and only on a few of the inhabitants of the same region,*' the direct and simultaneous action of climatic conditions upon all of the individuals inhabiting the same region was dwelt upon at length. Thus, to quote a few passages:

The local races of any given region, as compared collectively with those of contiguous regions, and the manner of their mutual intergradation, point plainly to some general or widely acting cause of differentiation. This is indicated by the constancy of the results, so many species, belonging to numerous and widely distinct groups, being similarly affected. * * * There is, however, a vast amount of unquestionable proof of the direct and constant action of climate and other conditions of life upon animals, and that such geographical variations as the thicker and softer fur of mammals inhabiting cold regions, smaller size and brighter colors at the southward, etc., do not require the action of natural selection, in its strict and proper sense, for their explanation. It is well known, for instance, that a flock of fine-wooled sheep, when taken to a hot climate, rapidly acquire a coarser and coarser fleece, till, in a few generations, it nearly loses its character of proper wool, and becomes simply hair; that the change affects simultaneously the whole flock, and is not brought about by one or two individuals acquiring a coarser fleece and through their descendants modifying the character of the herd. Furthermore, in the case of sheep, it is well known that certain countries are very favorable to the production of a fine fleece, and that fine-wooled breeds, even by man's aid, can not be perpetuated in other regions. Again, it is a fact of common observation that in birds and mammals colors become more or less faded toward the moulting season simply by the direct action of the elements—the tints of the fresh and the long-worn plumage or pelage being more or less strikingly different in the same individuals—and that this contrast at different seasons is more marked in arid than in moist regions, through the greater bleaching effect of a dry heated atmosphere and the more intense dazzling sunlight of regions that are not only cloudless, but lack the protection afforded by abundant vegetation.

But climatic conditions were not claimed in this essay as the only agent in the evolution of species and races. President Jordan has referred to the song birds of the family Drepanidæ in the Hawaiian Islands, with such remarkable diversity in the form of the bill and other features, which he ascribes, perhaps properly enough, in part to natural selection and in part to isolation. Upon such cases the following paragraph from my long-forgotten paper has some bearing:

[3] *The Radical Review*, No. 1, May, 1877, pp. 108–140.

[4] 'Origin of Species,' 5th ed., p. 168.

While so much is claimed * * * as due to climatic causes, it is admitted also that habits and food, and other conditions of life than those resulting from climate, have a marked effect in determining modifications of form and color among animals. A scarcity of a favorite kind of food will undoubtedly force species to subsist upon the next best that offers, which may be so different as to modify certain characters and fit the species to live upon the less desired food. A change of food may lead to modification of dentition, the muscles of mastication, and the organs of digestion, and, correlatively of other organs or parts of the body; the modification, however, arising simultaneously among all the descendants of the individuals thus driven to a change of diet, instead of appearing first in a single individual and becoming perpetuated in its descendants alone. Entomologists have found that, among insects of the same species, the forced or voluntary use of different food-plants gives rise to modifications of color and structure, and hence results in what have been termed phytophagic varieties or subspecies, and that man can also affect such changes at will by simply changing the food of the species. Again, the geological character of a country is well known to have a marked effect upon the size and color of animals inhabiting it, as is strikingly illustrated among molluscous animals, whose abundance, and even presence, is largely dependent upon the constituents of the soil. Over regions of the United States, for example, where the underlying rock is non-calcareous, the species are both few in number and sparsely represented. In respect to the fresh-water mussels, those of the same species from different streams are easily distinguishable by differences in the thickness of the shell, in color, shape, and ornamentation, so that the character of the shells themselves affords a clew to the locality of their origin. At some localities the species tend to become tuberculous or spinous * * *; at other localities, they acquire a very much thickened shell, or different colors, the same characteristics appearing simultaneously in quite diverse species, and thus becoming distinctive of particular localities. [After reference to mammals of certain regions being influenced in relation to size by the presence of calcareous or non-calcareous soils, and to the birds of the Galapagos Archipelago, with their short wings and large bills, etc., there follows:] The sedentary life necessitated by the confined habitats of species thus situated would naturally act more or less strongly on the organs of flight, and a reduction in the size of the wing would follow; not necessarily through the round-about process of natural selection, through the modification originally of a single individual, but by the direct action on all the individuals alike of the changed conditions of life.

There are thus what may be termed regional modifications due to the direct action of environment, independently of natural selection, in its original, restricted sense, or of isolation. The modifying influence may be either primarily climatic or due to peculiar constituents of the water or soil and the resultant vegetation. In a sense the two latter conditions may act as barriers, with the resultant effect of modified isolation. In general, however, in birds and mammals, in which regional modifications are so patent, the main factor is climate, the action general, and the transition between regions gradual. While all these influences may be as active on islands as on continents, there is in the former the powerful agency of isolation superimposed upon all the other agents that tend to the differentiation of animal forms.

J. A. ALLEN.

SCIENTIFIC BOOKS.

The Evolution Theory. By Dr. AUGUST WEISMANN, Professor of Zoology in the University of Freiberg in Breisgau. Translated with the author's cooperation by J. ARTHUR THOMSON, Regius Professor of Natural History in the University of Aberdeen, and MARGARET R. THOMSON. London, Edward Arnold. 1904. 2 vols., illustrated. Pp. 416 and 405.

No one, in the last thirty years, has contributed more to the discussion and investigation of evolutionary problems than has August Weismann. The present work marks the culmination of his long series of stimulating writings. His fertility in hypotheses and keenness of criticism are well known; not less noteworthy is his readiness to withdraw hypotheses when disproved, or to modify them to conform with new discoveries. Thus, the

reader of 'The Evolution Theory' will note many minor changes from the positions taken earlier by Weismann in 'The Germ Plasm,' yet the substance of his theory of evolution remains unchanged.

The fundamental idea in 'The Germ Plasm' was the mutual independence of soma and germ, that is, of the body exclusive of the reproductive cells on one hand, and the reproductive cells on the other hand. Each, it was maintained, might be modified without modification of the other. This idea, at the time a novel one, has been shown by subsequent investigations to be substantially correct. It is the great merit of Weismann to have inspired those investigations. Through experimental studies, in which American zoologists have borne an honorable part, the effects of various external agencies upon the soma have been carefully analyzed. What effect, if any, these external agencies have upon the germ plasm is less clear. The opponents of Weismann, in common with Darwin, have at times maintained that induced modifications of the soma were handed on directly to the germ plasm and thus became hereditary. Weismann has always denied any such modification of the germ plasm through the soma, but concedes a modification of the germ plasm *parallel* with that which is directly induced by the environment in the soma. The germ plasm, however, in his opinion, is less sensitive than the soma to environmental changes, and so responds only to continuous influences, not to those which last for a single generation only. In this way Weismann seeks to find a basis for the innumerable and often marvelously perfect adaptations of organisms to their environment.

Weismann insists upon the germinal origin of variations which are heritable, but concedes that germinal variation may be given a particular direction by the environment. These variations may at first be too slight to have selectional value, but by the persistent action of the environment will be increased until selectional value is attained. Further, they will make their appearance not in an occasional individual merely, as we should expect if they are due to chance, but in so much of the race as is subjected to the continuous influence of the same environment. In taking this position Weismann attaches less importance than formerly to natural selection, adopts a different conception of the origin of variations which are heritable, and accounts more fully for adaptations.

Weismann shows his open-mindedness and breadth of view in adopting from his opponents an idea upon which paleontologists have laid stress, that when an organism has once begun to vary in a given direction, there is an inherent internal tendency for it to go on varying in that same direction, this tendency being quite independent of the environment and due to a struggle of the determinants of the germ plasm among themselves, a process which Weismann calls germinal selection. To this position he has been led by two considerations: (1) that there occur among organisms adaptations too subtle and complicated to have selectional value in the struggle for existence, and (2) that many organisms are over-adapted, that is, have progressed beyond what is advantageous in a particular sort of adaptive variation, as, for example, the extinct Irish elk with his tree-like antlers.

'The Evolution Theory,' while containing a full exposition of Weismann's own views, includes much else. It contains an accurate and interesting historical account of the development of the evolutionary idea from its origin in the speculations of Greek philosophers to its culmination in Darwin's 'Origin of Species.' A very full account is given of Darwin's views and of the lines of evidence on which those views were based. The mutation theory of de Vries is critically examined, though it finds little favor in Weismann's eyes. Like Darwin, he considers sport variation (mutation) of small consequence in the production of species, believing its effects to be local and temporary, resulting in the production of small and peculiar groups within species, but not of the broader species groups themselves. In breadth of scope and fullness of treatment Weismann's book surpasses all other works on the same subject; it will doubtless long remain the authoritative statement of Darwinism.

The translation from the second German edition has been executed with rare skill and fidelity. The work of the publisher is also good.

W. E. Castle.

Bacteria in Relation to Plant Diseases. By Erwin F. Smith, in charge of Laboratory of Plant Pathology, Office of Physiology and Pathology, Bureau of Plant Industry, U. S. Department of Agriculture. Volume I., Methods of Work, and general literature of Bacteriology exclusive of Plant Diseases. Washington, D. C., published by the Carnegie Institution of Washington. September, 1905. Pp. xii + 285. 4to. Publication No. 27.

We are told in the preface that "the present volume contains an 'outline of methods of work' which was written up in substantially the same form four years ago, in connection with the investigations of the Laboratory of Plant Pathology, Bureau of Plant Industry, United States Department of Agriculture, its publication having been delayed in order to bring the rest of the manuscript into suitable shape." In its present form it is now published 'with the approval of the Secretary of Agriculture.' This book has thus a quasi-official authority, representing, as it does, the high standards set by the scientific bureaus of Washington.

The author says that his monograph 'is not intended to take the place of ordinary text-books of bacteriology, but rather to supplement them.' While primarily intended for the plant pathologist, 'it is hoped that it will be of value to physicians and animal pathologists for purposes of comparison.'

The principal topics touched upon in this volume are the nature of disease, the morphology, physiology and pathogenic character of the organism, the preparation and use of various kinds of culture media, economic aspects, methods of infection, methods of prevention, location and equipment of the laboratory, methods of work, microscopes, nomenclature and classification, working formulae etc. At the close of the book there is a classified bibliography including almost fourteen hundred titles, which must prove of the greatest value to the bacteriologist.

Turning to the section which deals with nomenclature and classification, one reads with a smile the crisp remarks of the author, as when he says 'the nomenclature of the bacteria is in a somewhat chaotic state, as might be expected of a science which has been cultivated so largely by medical men, and so comparatively little by systematic botanists and zoologists.' The designation of species by numbers and letters is condemned, as also the use of polynomials. Better descriptions are strongly urged, and far more care in associating a particular organism with a certain disease. The suggestion is made that the starting point for species should be 1881, when pure cultures became possible. The suggestion is made, also, that the starting point for genera should be 1872, the date of Cohn's 'Untersuchungen über Bakterien.' With some modifications the author adopts Migula's plan of classification in his 'System der Bakterien,' 'until some distinctly better system makes its appearance.'

On the question of the polymorphism or fixity of bacteria Dr. Smith holds 'a sort of middle ground':

> There can be no doubt that the same organism sometimes exists as a long filament in which no septa are visible, and at other times as a short or nearly isodiametric rod, but we are not thereby compelled to consider the short form as a *Micrococcus*, *i. e.*, as something very different from the long form. Physical conditions probably have much to do with bringing about these differences.

We should like to quote further from this very suggestive and helpful book, but must refer the reader to the volume itself. The value of this volume is so evident that we look with great interest for the second, whose publication it is hoped will not be long delayed.

Charles E. Bessey.

The University of Nebraska.

SCIENTIFIC JOURNALS AND ARTICLES.

The *Journal of Nervous and Mental Diseases* for November opens with a paper by D'Orsay Hecht in which he reviews the literature of dementia præcox, frequently illustrating the

points mentioned with cases from his own experience. The article is to be continued in the next issue. Dr. Ward A. Holden presents some statistics on the early ocular signs of dementia paralytica, and sums up as follows: "In true, uncomplicated paresis there is early in the disease almost constant absence of the sensory reflex, in half the cases irregularity of the pupils, in nearly half inequality of the pupils, in more than half abnormally small pupils, in a fifth of the cases loss of light reaction, in another fifth marked sluggishness of light reaction, and in a few of those with diminished light reaction a diminution of convergence reaction also. A preliminary paper on psychasthenia, its clinical entity illustrated by a case, is contributed by Sidney Schwab."

BEGINNING in January next, it is announced that the *Bulletin of the Geographical Society of Philadelphia* will be issued every three months. Professor Emory R. Johnson will be the responsible editor and will have the cooperation of Mr. Walter Sheldon Tower as associate editor. The past year has been the most prosperous one in the history of the society—judging by the increase in membership and general activity of the organization.

SOCIETIES AND ACADEMIES.

THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

THE association will hold its annual meeting on December 1 and 2 in the Y. M. C. A. building, 153 La Salle St., Chicago. The general meetings will be held on the second floor, and the section meetings on the seventh floor, of the building. The association, which has members in twelve states, invites all persons who are interested in the subject matter and the teaching of science and mathematics to become members. The program which follows may be had in pamphlet form upon application to the secretary, C. M. Turton, 440 Kenwood Terrace, Chicago, Ill.

GENERAL PROGRAM.

Friday, December 1.

9:00 A.M. Exhibits of apparatus, second floor of building.

10:00 A.M. General meeting.

Address—'Hypothesis of the Origin of the Earth,' Professor T. C. Chamberlin, head of department of geology, University of Chicago.

Address—'Relation of Forestry to Public School Instruction,' Ernest A. Sterling, U. S. Department of Forestry.

2:00 P.M. Section meetings, seventh floor of the building.

Saturday, December 2.

9:00 A.M. General meeting, reports of committees, general business, election of officers.

10:00 A.M. Section meetings.

1:30 P.M. Excursions by various sections.

PROGRAM—BIOLOGY SECTION.

Friday, December 1, 2:00 P.M.

'What and How Much Can be Done in Ecological and Physiological Zoology in Secondary Schools?' Oscar Riddle, Central High School, St. Louis, Mo.

Report of the committee on 'The Course in Biology in Secondary Schools,' Chairman Worralo Whitney, South Chicago High School.

Discussions based on the committee's report.

'Should Botany and Zoology be Taught in Full Year Courses?' G. H. Bretnall, Monmouth College.

'The Relative Emphasis to be Given to Morphology, Physiology, Ecology and Other Phases of Biology,' Miss Elma Chandler, Elgin High School.

'What, and How Much Field Study may be taught?' Fred. L. Charles, Normal School, De-Kalb, Ill.

'In What Order Should Animal and Plant Groups be Studied?' Miss Amelia McMinn, West Division High School, Milwaukee, Wis.

Open discussion.

Saturday, December 2, 10:00 A.M.

Election of officers and general business of the section.

The laboratory note-book problem, five-minute discussions.

'The Technique of Projection and Anesthesia of Animals, with Numerous Demonstrations,' A. H. Cole, Lake High School, Chicago.

Saturday Afternoon Excursions.—Washington Park Conservatory and Field Columbian Museum, Lincoln Park Conservatory and animal exhibit. Uihlein's orchid houses.

PROGRAM—CHEMISTRY SECTION.

Friday, December 1, 2:00 P.M.

'Recent Advances in Chemical Knowledge,' Dr. L. W. Jones, University of Chicago.

Discussion.

'Equipment of a Modern Chemical Laboratory

in the Secondary School,' Fred. J. Watson, McKinley High School, Chicago.

Discussion.

'Reference Books in Chemistry,' F. C. Irwin, Central High School, Detroit, Mich.; A. B. Crowe, State Normal School, Charleston, Ill.

Saturday, December 2, 10:00 A.M.

Election of officers and general business.

Address—'Investigations on Osmosis,' Dr. Louis Kahlenberg, University of Wisconsin.

Address—'New Theories of Matter in Relation to Chemical and Physical Theory,' Professor Charles T. Knipp, University of Illinois.

PROGRAM—EARTH SCIENCE SECTION.

Friday, December 1, 2:00 P.M.

Address—'Commercial Geography for Secondary Schools,' Dr. J. Paul Goode, University of Chicago.

Address—'The Work of the Hydrographic Office in its Relation to Commerce,' W. J. Wilson, nautical expert in charge of the Chicago Branch of the U. S. Hydrographic Office.

Report of committee on cooperation in gathering materials in teaching physiography, Charles Emerson Peet, chairman, Lewis Institute, Chicago.

Election of officers.

Saturday, December 2.

Excursions.—To the plant of the Automatic Electric Company, thence through a portion of the tunnels of the Illinois Telephone Company. The party will start immediately after the general session of the association, Saturday morning. To the Fat Stock Show and the packing houses at the Union Stock Yards. The party will start immediately after the general session of the association, on Saturday morning. An admission fee of fifty cents will be charged at the gates. Luncheon may be obtained at the yards. To the works of the Pullman Company; this is a joint excursion Saturday afternoon with the Physics Section.

For particulars see program of the Physics Section.

PROGRAM—PHYSICS SECTION.

Friday, December 1, 2:00 P.M.

Address—'The Value of Qualitative Experiment in Physics,' L. F. Miller, University of Wisconsin; 'The Aim of High School Physics Teaching.' E. E. Burns, Medill High School, Chicago.

Report of Committee on 'Reference Books in Physics,' A. H. Sage, State Normal School, Oshkosh, Wis.

Address—'The Teaching of Physics,' H. N. Chute, High School, Ann Arbor, Mich.

Informal Discussion: 'Should the attitude of the student be that of discoverer or verifier?' 'Is consultation of two or more students on a laboratory experiment disorder?' 'Is it certain that some experiments that require several hours to perform are more valuable to a student than the time spent in reading?' 'How many times is it profitable for a student to perform certain experiments for greater accuracy, for example, finding the latent heat of vaporization of water?' 'Must the student record every experiment?' 'Should work with scales and calipers be done in advance for the purpose of learning the use of the instruments, or should the operation be done for the first time when use requires it?'

Presentation of new physical apparatus, Mr. L. B. McMullen, Shortridge High School, Indianapolis.

Saturday, December 2, 10:00 A.M.

Election of officers.

Business.

Joint meeting with Chemistry Section, 10:15 A.M.

Address—'Investigations on Osmosis,' Dr. Louis Kahlenberg, University of Wisconsin.

Address—'New Theories of Matter in Relation to Chemical and Physical Theory,' Professor Charles T. Knipp, University of Illinois.

Saturday afternoon will be devoted to an excursion to the Pullman Palace Car Works, Pullman, Ill. Train will leave Randolph Street Station of the Illinois Central Railroad at 1:20 P.M. Those who wish may visit the Finsen Light Institute of America, Washington Boulevard and Hamlin Avenue.

PROGRAM—MATHEMATICS SECTION.

Friday, December 1, 2:00 P.M.

Address—'The Straight Line in Geometry,' J. W. Withers, principal, Teachers College, St. Louis.

Discussion.

Reports: Willard S. Bass, Francis W. Parker School, Chicago; Miss Mabel Sykes, South Chicago High School, Chicago.

Paper—'Interest and Progress in Teaching Mathematics,' N. J. Lennes, Wendell Phillips High School, Chicago.

Discussion.

Saturday, December 2, 10:00 A. M.

Election of officers.

Address—'Aids in Teaching Algebra,' Professor R. J. Aley, University of Indiana.

Discussion led by Miss Jessie J. Bullock, High School, Champaign, Ill.

Paper—'Some Thoughts on the Teaching of

Geometry,' C. A. Petterson, Jefferson High School, Chicago.

Discussion led by G. C. Shutts, State Normal School, Whitewater, Wis.

O. W. CALDWELL, *President*,
C. M. TURTON, *Secretary*.

THE ONONDAGA ACADEMY OF SCIENCE.

THE regular monthly meeting of the Onondaga Academy of Science was held Friday evening, October 20, 1905, the president, Dr. T. C. Hopkins, in the chair.

Mr. Charles E. Wheelock gave an interesting account of some overthrust faults occurring across central New York from Little Falls to Ithaca and which are most prominently developed in the Scalaris[1] and in the overlying Helderberg limestones. He tried to show that these disturbances were found only in rocks immediately overlying the Salina formations from which the various salts had been leached out. As the rocks of central New York dip slightly toward the south, the hypothenuse of the triangle would be shortened by the dropping down of the overlying formations due to the solution of the salts, and thus produce a lateral pressure in the rocks capable of producing the overthrusts.

Professor Philip F. Schneider read an interesting paper on 'The Correlation of Some Alnoite Dikes in East Canada Creek.' Heretofore but three dikes were known at East Canada Creek, showing only on the Montgomery side, with a narrow dike on the Herkimer side which it was impossible to correlate with either of the others. The paper established the fact that there were five dikes on the east side and also five corresponding dikes on the west side of the stream. All were located accurately and figures given as to their width, distances apart and strike, showing that they were corresponding dikes. Megascopically the dikes bear a close resemblance to those already known and it is believed that a microscopic study of the same would show that they are practically identical.

[1] The Scalaris limestone as described by P. F. Schneider in the October, 1905, number of the *American Journal of Science* is the prominent limestone ledge in the Camillus Shale of the Salina formation and immediately underneath the gypsum deposits. It is the first formation of the salt deposit in central New York containing fossils, the *Leperditia Scalaris* Jones being the most abundant.

Dr. Daniel S. Martin, of Brooklyn, spoke of the close resemblance of the peridotite dikes in New York, Kentucky and South Africa and the possibility of diamonds occurring in them in this country. While the material composing all these dikes is practically identical, as shown by their petrographic study and chemical analyses, even to the extent of their containing certain gems in common, as the pyropes and olivenes, nevertheless the diamond is conspicuous by its presence in the African fields and equally conspicuous by its absence in the American localities.

President T. C. Hopkins spoke of the rumor that two diamonds had been found in the drift deposits south of Syracuse. The owner of the sand bed claimed to have found a good-sized diamond in the drift which was deposited in a Syracuse bank and later sold to a party in Springfield, Mass., for two hundred and fifty dollars. Another so-called diamond obtained from this same sand pit was shown to Dr. Hopkins by the owner, but a hasty examination convinced him that it was a topaz. However, nothing positive was known concerning the character of the first found stone. Geologists were advised to watch carefully excavations, both in the disintegrated dike and in the drift material, for possible diamonds.

PHILIP F. SCHNEIDER,
Secretary.

DISCUSSION AND CORRESPONDENCE.

HONORARY DEGREES.

TO THE EDITOR OF SCIENCE: I have been very much interested in your note in the issue of October 27, concerning the honorary degrees conferred at the recent inaugural of the University of Illinois. Instead of the too prevalent practise of conferring the degree of doctor of laws indiscriminately on all of the gentlemen whom it was desired to recognize, it is pleasing to see the degree of doctor of science given to a gentleman of distinguished scientific attainments, that of doctor of engi-

neering to an accomplished and distinguished engineer as well as to the successful dean of a school of engineering, and that of doctor of agriculture conferred on gentlemen who have done much to promote this great profession.

I should like to call attention to the discussion before the American Society of Naturalists at its St. Louis meeting, as reported in SCIENCE of May 27, 1904, in which the question of honorary degrees was analyzed by a number of distinguished speakers, in connection with that of degrees at large. May it not be hoped that the attention of those having it in their power to confer such degrees may be directed once more to the desirability of such differentiation as the University of Illinois has here applied? WILLIAM TRELEASE.

SPECIAL ARTICLES.

THE ORIGIN OF BLACK SHEEP IN THE FLOCK.

THE phrase 'Every flock has its black sheep' connotes the sporadic nature of their appearance. They crop out in flocks of breeding ewes and rams that are wholly white. When a quality suddenly arises from parents that have its opposite the probability is that the two opposed qualities follow Mendel's law in inheritance and that the new, filial character is recessive, the parental opposite dominant.

There are four tests of recessiveness. First, if the germ gland contains the dominant characteristic that characteristic, and not the recessive, will show in the soma; consequently, the patency of the recessive in the soma of any individual indicates that its germ gland contains only the recessive quality. Hence, when two recessive individuals are interbred they will produce only recessive offspring.

Second, if a recessive individual is mated with a heterogametous individual—*i. e.,* one which because of mixed ancestry, has both dominant and recessive germ cells—fifty per cent. of the offspring should be recessive.

Third, if two heterogametous individuals be mated, twenty-five per cent. of the offspring should, in the long run, be recessive.

Fourth, if recessive individuals (having exclusively recessive germ cells) mate with pure dominant individuals (having exclusively dominant germ cells) the soma of the hybrids must show the dominant characteristic.

An opportunity to test the recessiveness of the black coat in sheep is afforded by the 'Sheep Catalogue' of Dr. Alexander Graham Bell's (1904) flock,[1] giving the records of 877 sheep used or acquired in pedigree breeding by Dr. Bell. We may apply in turn the four criteria.

First, of twenty offspring both of whose parents were black, nineteen were black. When I discovered this fact I wrote to Dr. Bell concerning the exception (No. 814, white, female), and he was good enough to reply:

> I have examined the original entry of birth of 814 and find her reported as wf 4n s born March 23, 1898, out of 712 bf 4n s by 626 bm 5n tw:—still-born, weight 2 pounds. This lamb was still-born and was born in March, this means that I did not see the lamb myself for I am not usually at Cape Breton at that time, and there has not been any verification of color.

Dr. Bell goes on to state that his shepherd has made errors in recording black as white, and *vice versa,* but these "have been corrected by subsequent examination. In this case, as the animal was still-born, the record rests entirely upon the unsupported statement of the shepherd." We may consequently neglect No. 814 and conclude that all descendants of two black parents are black. This result is in accord with the hypothesis that black is recessive.

Second, of 51 offspring of a recessive (black) individual that was heterogametous (because a hybrid between a white and a black parent) 26 were white and 25 black. This accords with the hypothesis that black is recessive.

Third, of 47 offspring, each from two heterogametous parents, 40 were white and 7 black. In every family but one the proportion of blacks is below the 25 per cent. expectation. The result is not in strict accord with Mendelism, although closely allied with it. There is evidently some modifying factor. It may

[1] Bell, Alexander Graham, 1904, 'Sheep Catalogue of Beinn Bhreagh, Victoria Co., Nova Scotia: Showing the Origin of the Multinippled Sheep of Beinn Bhreagh and Giving all the Descendants Down to 1903.' 22 pp. Washington, D. C.

help us if we assume a greater vigor of the white germ cells, so that unions do not take place in hap-hazard fashion, but two germ cells bearing black are less apt to get together than two bearing white, pure black zygotes being produced in less than one fourth of the cases.

We may conclude, then, that while the third criterion of recessiveness is imperfectly met this does not militate against the recessiveness of black in the Mendelian sense, but indicates the presence of a second, disturbing, factor.

The fourth criterion is the least critical because of the impossibility of judging whether a dominant is homogametous or not, except by its performance; if the hybrids are not dominants we conclude that the parent is not a pure dominant. The existence, however, of white individuals which always throw whites when mated with blacks is significant in relation to this criterion. Three white parents, descended, so far as known, from white ancestors, produced, when crossed with black sheep, 13 offspring, all white.

A special case deserves particular mention. No. 907 is a white male both of whose parents, 606 and 810, are also white, but both of whose grandfathers are black. Consequently, 606 and 810 are heterogametous but, until tested, we have no means of knowing whether their son, 907, is heterogametous or has only white germ cells. When No. 907 was crossed with heterogametous, white females all offspring were white. This would indicate that No. 907 is homogametous. When No. 907 was, however, crossed with pure recessives (blacks) one out of five offspring was black, and when crossed with 'extracted' recessives (having one heterogametous white parent) it produced two black offspring out of 18. In relation to these three offspring out of 23, assuming the record to be correct, No. 907 acts as if heterogametous. The occasional appearance of black offspring from a homogametous and a heterogametous parent may be explained as an occasional prepotency of black over the dominant white,—a phenomenon described by Castle[3] (1905, p. 58 et folg.).

[3] Castle, W. E., 1905, 'Heredity of Coat Characters in Guinea-Pigs and Rabbits.' Papers of Station for Experimental Evolution at Cold Spring Harbor, New York, No. 2.

It may be concluded that the fourth criterion also speaks for the recessiveness of black, the only exceptional case being explained on special grounds.

The conclusion of the whole matter is that black wool color in sheep behaves like a Mendelian recessive characteristic.

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PHOTOTROPISM IN THE LARVAL AND EARLY ADOLESCENT STAGES OF HOMARUS AMERICANUS.

In view of the interest which, by the recent excellent work of Keeble and Gamble on the color physiology of higher crustacea, has been renewed in the study of the effects of light upon many forms of littoral crustacea, the following results obtained during the past summer, in a series of experiments upon the effect of light on the larval and early adolescent stages of the American lobster, may be appreciated by some who are engaged in investigation of a similar nature upon other forms. The records of the following experiments cover but a small part of the field of inquiry into the effect of light upon these forms, in so much as they do not take up the subject of the influence of light upon chromatophore activity or pigment movement, but merely attempt to describe the reactions of the first five stages of *Homarus americanus* to light, upon backgrounds of black and white.

The apparatus used for the experiments consisted of an oblong wooden box whose inside dimensions were 6 x 18 x 4 inches (deep). The box was black inside and fitted with a light-tight cover, through one end of which protruded, to a length of 6 inches, a cardboard tube, 1½ inches in diameter, the function of this tube being to admit none but nearly parallel rays of light into one end of the box, thus distinctly localizing the light area. In cases wherein a white background was required, the black interior of the box was merely covered with white paper, as was the inside of the light-tight cover.[1]

[1] The design of the box is based upon that of Keeble and Gamble.

The method of conducting a single experiment was essentially as follows: The box was filled with salt water to a depth of 2 inches or thereabouts, and placed in a quiet and level position. The desired number of lobsters, together with sufficient salt water to make the total depth about 3 inches were added. When the water had quieted and the young lobsters had arranged themselves more or less uniformly in the water area, the cover was placed in position. At intervals, varying from 5 to 15 minutes, the cover was removed and the position of the young lobsters was observed. After some of the observations the cover would be reversed in position, so that the illuminated area in the water would be changed to the opposite end of the box. After other observations, however, the cover would be left as in the first instance, or removed entirely until another uniform distribution in the position of the young lobsters had been obtained. Whether the position of the cover was changed or not, the results, with few exceptions, agreed with great uniformity.

The light intensity was regulated by the time of day at which the observations were made—either at noon, mid-afternoon or nearly evening. In this way, without using artificial means, it was possible to regulate the degree of light intensity with a very fair degree of precision. In the case of studying monochromatic lights (red and blue) sheets of glass were used, the plate being placed over the entrance of the tube. Without doubt, liquid filters would have been an advantage; but the experiments which were made with glass plates gave such marked and definite reactions that they were judged satisfactory for preliminary work.

The counts were made by dividing the field into three areas, namely, the illuminated, the mid-area and the dark. Owing to the fact, however, that the illumination in the mid-area must have been almost imperceptible, for practical results it might have been quite safe to include the mid-area counts with those of the dark area, but for sake of surety they have been considered as a separate area. In the greater number of cases it was an easy matter to count the number of individuals in each of the three areas before a change in position took place. The number of twenty individuals was, in most cases, used for experimentation, for so small a number distributed over three areas could be taken in at a glance, and furthermore twenty seemed a sufficient number to give representative results. In the following account are recorded experiments carried on with the first five stages of *Homarus*. All the conditions of light and backgrounds were not brought to bear upon all five stages, and only a sufficient number of experimentation reports are here recorded to show the general drift of the results.

EXPERIMENT I.

Conditions: black background; sunlight dull; 20 first stage larvæ.

Test.	Lt. End.	Mid-area.	Dk. End.	Cover.
1	2	6	12	
2	3	4	13	Reversed.
3	1	5	14	
4	3	4	13	Reversed.

Similar results were obtained when a greater intensity of light was used.

EXPERIMENT II.

Conditions: white background; sunlight dull; 20 individuals used, first stage.

Test.	Lt. End.	Mid-area.	Dk. End.	Cover.
1	2	5	13	
2	2	2	16	Reversed.
3	2	3	15	Reversed.
4	1	5	14	

EXPERIMENT III.

Conditions: white background; sunlight bright; 30 individuals used, first stage.

Test.	Lt. End.	Mid-area.	Dk. End.	Cover.
1	22	4	4	
2	18	7	5	Reversed.
3	20	7	3	

These results seem to show that the first larval stage of *Homarus* is negatively phototropic on a black background, with both dull and bright light; but that while on white backgrounds he is, under low intensity, negatively phototropic, if the intensity of light becomes greater he becomes positively phototropic. Similar results were obtained with

second and third stage larvæ under similar conditions of light and background.

EXPERIMENT IV.

Conditions: white background; red monochromatic light; 20 first stage larvæ.

Test.	Lt. End.	Mid-area.	Dk. End.	Cover.
1	2	1	17	
2	2	3	15	
3	3	4	13	Reversed.
4	6	2	12	

EXPERIMENT V.

Conditions: white background; blue monochromatic light; 20 first stage larvæ.

Test.	Lt. End.	Mid-area.	Dk. End.	Cover.
1	12	4	4	
2	11	3	6	Reversed.
3	13	2	5	

These two experiments indicate that in the case of a white background and red monochromatic light, the first stage lobsters are negatively phototropic, while in the case of a white background and a blue monochromatic light the same lobsters are positively phototropic. This was naturally somewhat unexpected, but in all the experiments involving similar conditions of light and background, the second and third stage lobsters respond in a similar manner. In case, however, a black background is used with lobsters of the first three stages, numerous experiments demonstrate a negative phototropism under the conditions of both red and blue light.

EXPERIMENT VI.

Conditions: black background; 20 early fourth stage lobsters; sunlight bright.

Test.	Lt. End.	Mid-area.	Dk. End.	Cover.
1	13	3	4	
2	15	3	2	Reversed.
3	12	4	4	
4	15	4	1	

When experiments were tried with the fourth stage, however, a different reaction was found to occur. On black backgrounds and with lights of any intensity or color, the fourth stage lobsters appeared, contrary to the first three stages, positively phototropic, as the following table demonstrates. The degree of light intensity made no further change in the results, save that in instances where the light was the least intense the reaction was least marked; and when the light was most intense, as obtained by reflecting rays of light by means of a mirror into the tube, the definiteness of reaction was most evident.

When white backgrounds were used in connection with the fourth stage lobsters, it was found that in every case except with the monochromatic red light, a positive phototropic reaction resulted. The latter, which was also contrary to expectations, may be outlined as follows:

EXPERIMENT VII.

Conditions: white background; monochromatic red light; 20 early fourth stage lobsters.

Test.	Lt. End.	Mid-area.	Dk. End.	Cover.
1	8	5	6	
2	1	6	13	Reversed.
3	1	10	9	Reversed.
4	4	5	11	

These resulting reactions in the case of the early fourth stage lobster may offer an explanation for the fact that this stage is so frequently caught in tow-nets drawn over the surface of any of our shore waters, while it has been a very unusual occurrence to secure in this manner either the earlier or the later stages. The same causes may also have worth for the reported facts that certain stages of the free-swimming larvæ of other forms of crustacea are found more frequently at the surface than are other larval stages of the same species.

It was a noteworthy fact, however, that old fourth stage lobsters would never manifest positive phototropic reactions with the same degree of certainty as that demonstrated in the case of younger fourth stage lobsters. Indeed, in a number of instances, fourth stage individuals which were due to molt within a period of one or two days, manifested on black backgrounds a definite tendency towards a negative phototropic reaction. This response was assumed without exception after the lobsters had molted into the fifth stage, and this reaction was manifested with any combination of light intensity, color or background. The following tables show the reac-

tions in the case of the late fourth and the fifth stage lobsters.

EXPERIMENT VIII.

Conditions: black background (similar results were seldom obtained on a white background); sunlight bright; 20 late fourth stage lobsters.

Test.	Lt. End.	Mid-area.	Dk. End.	Cover.
1	9	4	7	
2	11	5	4	Reversed.
3	7	6	7	
4	9	3	8	

EXPERIMENT IX.

Conditions: black background; medium sunlight; 12 fifth stage lobsters.

Test.	Lt. End.	Mid-area.	Dk. End.	Cover.
1	2	4	6	
2	2	3	7	
3	2	2	8	Reversed.
4	1	3	8	

The results of these experiments may also explain, to a certain degree, the facts which appear through the observation of large numbers of the larval stages of *Homarus* when confined and exposed to different light conditions, as they may also interpret to some extent the behavior observed in the larval and early adolescent stages of lobsters under natural conditions of environment. The first three larval stages, when confined in the large twelve-foot white canvas bags in which they were observed, manifested at all times a marked tendency to sink toward the bottom—except perchance at night, when more active swimming is observed in all the stages. This tendency during the daytime could not be controlled in any way. At night, however, it was possible to evoke a seemingly positive phototropic reaction from any of the thousands of young larvæ in the large canvas bags. This was accomplished by means of an acetylene light so directed against a certain area of the white field of canvas that large numbers would at once group themselves thickly about the illuminated area, manifesting, in the case of the third and fourth stages, such an effort to come into the light area that they would often throw themselves partially out of water, causing thereby numerous surface ripples. Since, however, similar results could be obtained when a black background was employed with the acetylene rays, and since the results were not so definite when the incident rays struck the water perpendicularly as when they were thrown at an angle, it was assumed that these reactions were not true phototropisms, but were largely due to the effort on the part of the young lobsters to move in the direction of the incident light rays. This phenomenon was better observable in the fourth stage of *Homarus*, when the very definite rheotropic proclivity, first clearly observable in this stage, could be entirely broken up by introducing the incident rays either at right-angles to or in opposition to the direction of the current. The fourth stage lobsters, however, even under the natural conditions of light, swim actively at the surface. It is not until the fifth stage that the bottom-seeking and 'hiding-habit' is fully established.

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October 10, 1905.

AN ILLUSTRATION OF THE USE OF THE WIRE-BASKET METHOD FOR SOIL TESTING.[1]

THE method of cultures in paraffined wire baskets, for determining the relative agricultural values of soils and for investigating the effects of various fertilizers, which was described in Bulletin No. 23 of this bureau, consists in growing wheat seedlings in the soils to be tested for from two to three weeks, determination being made of the water lost by transpiration and of the green and dry weights of the plants at the end of the period. Where differences between the various treatments are developed it is found that the transpiration varies with the weight, being, therefore, a fair measure of growth.[2] This method, which virtually furnishes a pot the walls of which are composed of soil cemented with paraffin, causes a uniform distribution of roots in the soil and exhibits the effects of

[1] By permission of the Secretary of Agriculture.

[2] See in this regard a paper on the relation of transpiration to growth in wheat, about to appear in the *Botanical Gazette*.

various soils upon growth much more clearly than do cultures in ordinary pots, where most of the roots come to lie between the soil surface and that of the pot.

The soil of the present illustration is of the Orangeburg clay type, from South Carolina. Another sample of the same type from Texas is used for comparison. The soil is generally very fertile in both states. To investigate the effects of fertilizers upon the sample from South Carolina, wheat cultures in paraffined wire baskets were grown for three weeks in this soil with various treatments. By this means the surprising discovery was made that the untreated soil gave an exceedingly poor growth of the wheat plants, and that it was not appreciably benefited by any one of a large number of treatments used. An experiment was then carried out to compare this soil with the Texas sample of the same type and with Takoma lawn soil (see Bulletin No. 23 of this bureau), one of the poorest soils with which the bureau has dealt. Transpiration data from thirty plants for twelve days showed that, considering the transpiration on Takoma soil as 100, that on the South Carolina sample was 41, while that on the Texas sample was 209. On the same basis the green weights of the plant tops grown on the two soils were 35 and 216, respectively. Thus by the basket method it appears that this particular sample from South Carolina is exceedingly unproductive, and that the unproductivity is not corrected by fertilizers.

It seemed possible that the observed sterility might be due to the presence of toxic organic substances in the soil. Such toxic substances have been found to be readily transmitted to the soil extract and to show their characteristic effects therein, and so to determine whether or not such substances were present here wheat seedlings were grown in aqueous extracts of the two soils from South Carolina and Texas. These extracts were prepared as described in Bulletin No. 23, by stirring for three minutes five parts by weight of soil with six parts of water, allowing the mixture to stand twenty minutes and then filtering off the extract through a Pasteur-Chamberland filter tube. The plants of the present experiment showed somewhat better growth in the Texas extract, but the difference was not marked. The transpirations from the two cultures of sixteen seedlings each, grown sixteen days, were, for the South Carolina sample 118.4 g. and 117.1 g., and for the Texas sample 148.8 g. and 129.3 g., respectively. This indicates that the soil to be tested contains no soluble organic substances markedly toxic to the plants and that it does contain sufficient soluble inorganic material for normal plant growth. Its infertility must, therefore, be due either to some physical property of the soil or to too great a concentration of the soluble salts in the soil. The effect of such concentration might be overcome to a very large extent by the much greater dilution of the soil extract.

To determine whether the infertility might be due to too great concentration of soluble matter, the South Carolina sample was leached by passing about an equal volume of water through it, and the leached sample was compared with the Takoma soil by another basket experiment which ran for six days. Considering the transpiration and green weight each as 100 for the Takoma soil, the figures obtained from the leached soil were 196 and 152, respectively. Thus by leaching the soil its power to support plant growth was increased from 41 to 196 by transpiration and from 35 to 152 by green weight. On the same basis, the fertility of the Texas sample is represented by 209 for transpiration and 216 for green weight, so that by leaching the sterile sample it has been improved in fertility so as to be nearly equal to the Texas sample. These results show that the sterility of the South Carolina sample, at least as far as seedling wheat plants are concerned, is probably due to an excess of soluble salts. Chemical analysis of the water extract of the South Carolina sample showed the following amounts of dissolved materials, expressed in parts per million of the air dry soil by weight: NO_3, 611; PO_4, trace; SO_4, trace; K, 100; Ca, 11; and Cl, 175. The large amounts of nitrate, chloride and potassium here found seem to cor-

roborate the conclusion reached by the method of basket cultures.

To test this proposition still further, the baskets of untreated soil used in the first fertilizer test were replanted and the plants allowed to grow three weeks. The result showed the soil to have improved to the extent of about 183 per cent. by transpiration and 86 per cent. by green weight. This observation suggested that possibly the plants of the first planting had absorbed from the soil sufficient salts to reduce the concentration of the soil solution to a considerable degree, although the plants had made but a poor growth, and that in this way the injurious property of the original sample had been largely corrected. At the end of this second culture the soil was again subjected to a chemical analysis of its water extract, with results which showed clearly that the above explanation is the correct one. The following amounts of dissolved materials, expressed as before in parts per million of air dry soil, were found: NO_3, 87; PO_4, trace; K, 29; Ca, 4; and Cl, 100. It is obvious that a marked decrease in dissolved salts has indeed taken place.

While the last test was in progress basket cultures were carried on with three new samples of this soil from other spots in the same field, these having been obtained in order to determine whether or not the first sample was typical of the whole field. The average growth in the three new samples was very much better than that in the first planting of the original samples, the difference amounting to 322 per cent. by transpiration and 110 per cent. by green weight. Thus it became apparent that the original soil sample was not typical of the field from which it was taken and that in general the field is not unproductive.

It appears then that the particular spot from which the original sample was taken has in some way, possibly by over-fertilization, too high a soluble salt content for good plant growth.

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OBSERVATIONS ON COLOR PERCEPTION AMONG THE VISAYANS OF LEYTE ISLAND, P. I.

As a United States government teacher in the public schools of Leyte Island, I became interested in the dialect of the Visayans. In this study I found frequently suggested what sort of men the Visayans were when the Spaniards came to their islands. The modified Spanish words in the vocabulary of the present native designate ideas given to the Visayans by the Spaniards. It was not long before I was confronted with the same question that Gladstone encountered in his study of Greek. Gladstone by pointing out that in the Homeric vocabulary there were no words for blue, and by concluding that in the time of Homer the Greeks did not see blue, opened quite a controversy over the evolution of color perception as based upon the nomenclatures of ancient people and savages of the present. Geiger advanced the theory that red was the first color seen by man and after that the other colors in their order as formed by the spectrum. Geiger was supported by Magnus with further philological evidence. This discussion until recently had been considered closed. Havelock Ellis in Vol. 69 of *The Contemporary Review* at page 715 says: "There is no doubt whatever that all races of men, concerning whom any evidence can be obtained, have been acquainted with the same regions of the spectrum we have known." After so strong a statement I was surprised to find Rivers, who had made extensive experiments upon the Papuans of Torres Straits, saying of his work that one of its chief interests 'is that it shows a defect in nomenclature for a color may be associated with defective sensibility for that color and so far lends support to the views of Gladstone and Geiger.'[1] The evidence that I have obtained among the Visayans also supports the views of Gladstone and Geiger. My discovery that the people had no words for the colors higher than yellow was new to me, but I later learned that this fact was known as early as 1869. Words for the higher colors which are used to-day by the natives are bor-

[1] 'Reports of the Cambridge Anthropological Expedition,' Cambridge, 1901, Vol. II, Part I., p. 49.

rowed Spanish terms. I found *siga, meserum, mabosag, maitum, mapula* and *madarag* were fixed words for *light, darkness, white, black, red* and *yellow,* respectively. I tried all methods suggested to find pure Visayan words designating the colors of more rapid rates of oscillations. All classes of the people were consulted, but no such words were brought to light.

The most comprehensive dictionary of the Visayan as spoken by the people of Leyte is the large 'Diccionario Hispanio-Bisaya; Bisaya-Hispanio,' by R. P. Fr. Antonio Sanchez. From it the following was taken:

Spanish.	Visaya.	English.
Verde.	Lunhao, hilao, hayat, banua.	Green.
de Café.	de Café.	Brown.
Purpuro.	Purpuro.	Purple.

Here we see given four Visayan words for green. None of these, however, is actually used by the natives for designating green. So we turned to the Bisaya-Hispanio part of the dictionary and found the following:

Visaya.	Spanish.	English.
Lunhao.	Color verde.	Color green.
Hilao.	Cosa cruda; verde.	Thing crude; green.
Hayat.	Cosa verde; sin maduraion.	Thing green; without maturity.

It will be seen here that all the words used for the definition of the Spanish verde express rather the general condition common to things not dried, things unripe and the general appearance of the grass, fields and forests —*lunhao* excepted. For six months I carried *lunhao* about with me. I could find but one man to recognize this word. El Capitan Louis Cordero, an intelligent citizen of Burauen, explained to me that it did not express the idea of verde or green, but that it also had reference to an uncured state. He gave as an example the condition of nipa thatching before it was completely dried and ready for use. *Lunhao,* therefore, is an exceedingly doubtful word by which to express the idea of green. In fact my efforts led me to conclude that it does not have any such meaning. But be that as it may it is quite a suggestive fact that so much vagueness hangs about the idea of green as expressed in truly Visayan words.

And when we come to the color next higher in the scale of the spectrum we find no Visayan word whatever given for it. The dictionaries give the Spanish *azul* modified into *asul.* And this is the only word the natives use. For violet and other colors nothing but pure Spanish words are used. So far as the present dialect is concerned we are led to infer that until the Spaniards came the Visayans had no ideas of green, blue and violet, which demanded words for their expression.

But not satisfied with these observations, I turned to the children of the island. Children, of course, can not be expected to handle colors as well as adults. But with this caution in mind some results were obtained which, because of their lack of variation are of considerable interest.

In speaking with the American teachers I learned that they experienced difficulty in getting the children to recognize colors. Mr. B. M. Sullivan, an American teacher at Dagami, pointed out to me the fact that 'the ladies nearly always wear red and yellow. When they do wear dark blue they call it black. Their light blue skirts they call green.'

On February 15, 1902, a purple kite sailed by my window. This a boy servant, twelve years old, pronounced de café—brown. Later he called the same kite red. On March 27, 1902, another servant, seventeen years old, bought a pair of purple slippers, which he said were brown.

On March 14, 1902, while I was sitting with Mr. Sullivan, six little girls came into his room. They were about nine years old. These little girls had never seen the green hyloplate writing boards which the educational department had recently sent. The girls were soon before them eagerly disputing their color, for they had expected writing boards to be black. Were they green, blue or black was a difficult question for them. After much dis-

cussion and reading of our faces they finally decided that they were green.

Several days later we took the matter of color perception into the Dagami schools. Mr. Sullivan, their teacher, asked a nine-year-old girl the color of a handkerchief that she wore about her neck. She answered correctly that it was blue. But to his next question she replied that the grass was the same color. Another girl about ten years old pronounced a rather dark green leaf *maitum*—black. A class of thirteen girls in the same school, ranging in age from eight to twelve years, named properly and without any difficulty the colors of pencils painted red and yellow. But the green and blue pencils they could not at all name. They simply could not perceive the green and blue as such.

On September 9, 1902, in dealing with a class nine to ten years or older, who had had no chance either in Spanish or American times to improve themselves, I found them very ready to recognize red and yellow. All seven would respond with the proper Visayan words for these colors. One of the class wore dark blue trousers; they were decidedly blue, yet not as dark as navy blue. For the color of these trousers six of the boys gave the Visayan word *maitum*—black—and the seventh boy, to get ahead of his classmates, shouted out the Spanish word *negro*—black. The same class had no difficulty with the red and yellow as given in the color chart of E. G. Regal's 'Lessons for Little Readers,' Heath and Company. But I found they as readily called light blue green or brown as anything, and no better did they handle the green.

Mr. H. E. Guyer, one of the American teachers at Tacloban, gave me the following statement:

> The dullest boy in my school has never called a red ball anything but a red ball. Except for a thoughtless boy's answer they invariably call a yellow ball yellow. In other colors I can not rely upon them, except some few who have memorized them. And even they flounder if I mix the colors up.

It has been suggested that these observations may be worthless on the ground that any children might make similar mistakes in naming colors. I can not think that these observations can be explained away in this manner, because, in the first place, if this were the cause the colors mistaken would not have been so constantly green and blue. And, secondly, this differs radically from results of experiments made upon children of parents who have a well-defined perception of blue and green. Marx Lobsien in a series of experiments upon German school children observed that the three fundamental colors, *Rot, Gelb* und *Blau,* were almost accurately handled. Of these blue was more accurately handled than yellow. "Nach meinen Untersuchungen steht am höchsten in der Wertung da das Rot. Es wurde auf allen Alterstufen immer richtig aufgefasst und benannt; ihm fast gleich, nur auf der fünften Stufe findet sich eine kleine Unterschwankung, ist das Blau, dann folgen 3 Gelb, 4 Grün, während Orange, Violette, Indigo unverhältnissmässig ungünstig dastehen."[2]

It has also been explained that primitive men have no words for green and blue because they have no interest in these colors. Rivers found that the Paupan name for red was the modified term used to designate the female parrot *Eclectus polychlorus.* On the island of Leyte there is a dark blue snake with a yellow head which the natives fear greatly because of its poisonous fangs. If so inoffensive an animal as a parrot could have attracted the early Paupans and given them their name for red, one marvels that the early Visayans were not attracted by this snake to blue. I have no doubt that other instances could be found in which green and blue were strikingly presented, so that the pre-Spanish Visayans would have taken notice of them if they had seen these colors as such.

These observations, therefore, lend weight to the theory that the eye, in its evolution as a color-sensing organ, saw at first only the colors at the red end of the spectrum; and seem to show that the Visayans, at least at the time when they were discovered by the

[2] *Zeitsch. f. Psych. und Phys., etc.*, Bd. XXXIV., Heft I., January 19, 1904, p. 35.

Spanish, were still in the stage when red and yellow were the only colors clearly perceived.[3]

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THE academy held its autumn meeting at the Sheffield Scientific School of Yale University, on November 14 and 15. The scientific program was as follows:

JOHN TROWBRIDGE: 'Slow movements of electrical discharges.'

E. B. WILSON: 'Sex-determination and the chromosomes.'

L. B. MENDEL: 'Studies on the chemical physiology of development and growth.' (Introduced by R. H. Chittenden.)

W. M. DAVIS: 'The Dwyka glacial conglomerate of South Africa.' (Illustrated by lantern slides.)

B. B. BOLTWOOD: 'The disintegration products of thorium as indicated by the proportions of lead and helium in minerals.' (Introduced by H. L. Wells.)

A. HALL: 'Relation of the true anomalies in a parabola and a very eccentric ellipse having the same perihelion distance.'

S. L. PENFIELD: 'On a new mineral from Borax Lake, California.'

F. E. BEACH: 'On errors of excentricity and collimation in the human eye.' (Introduced by C. S. Hastings.)

C. S. PEIRCE: 'The relation of betweenness and Royce's O-collections.'

L. P. WHEELER: 'Some problems in metallic reflection.' (Introduced by C. S. Hastings.)

FRANZ BOAS: 'On Pearson's formulas of skew distribution of variates.'

A. AGASSIZ: 'On the variation in the spines of sea urchins.'

W. H. BREWER: 'Further observations on sedimentation.'

H. A. BUMSTEAD: 'The effect of Röntgen rays on certain metals.' (Introduced by C. S. Hastings.)

THE GEOLOGICAL SOCIETY OF AMERICA.

THE eighteenth annual meeting of the Geological Society of America will be held on December 27, 28 and 29, in Ottawa City, the Canadian capital. The circular of information issued by Secretary Fairchild gives the details of arrangements for the meeting there, and facilities regarding customs as well as railway and hotel accommodation usually given to the fellows of the society.

Ottawa is easily reached from all railway centers and is one of the most progressive cities of the Dominion, being the seat of government and the headquarters of the Geological Survey Department. This official survey, which began in 1842, has continued its operations uninterruptedly and there is now attached to the department a Museum of Geology, for petrography, general geology and historical geology, as well as for paleontology. Type specimens of Canadian fossils, described by Billings, by Whiteaves, Sir William Dawson, by Rupert Jones and by various other well-known authors, are deposited in the collections and can be seen to advantage.

A large attendance is expected at this meeting, many having already signified their intention of being present. A local committee has charge of the details of the meeting, and the evening sessions promise to be of an interesting nature. The annual dinner of the society will be followed by a reception at which the governor general will be present. The Russell House will be the headquarters. Rates are very reasonable, and every comfort will be provided for the guests attending the meeting. All parcels serving to illustrate papers to be presented at the meeting will be admitted free of duty by the commissioner of customs if addressed to Dr. H. M. Ami, Headquarters of the Geological Society of America, Russell House, Ottawa, Canada.

The society met at Ottawa in 1892 under the presidency of Professor B. K. Emerson. This year Professor Raphael Pumpelly is the president.

THE ROYAL SOCIETY'S MEDALS.

THE following is a list of those to whom the Royal Society has this year awarded medals:

The Copley medal to Professor Dmitri Ivanovitch Mendeléef, of St. Petersburg, for

[3] I am indebted to Professor R. S. Woodworth, of Columbia University, for valuable suggestions and references to literature. He is not, however, responsible for the conclusions advocated.

his contributions to chemical and physical science.

A Royal medal to Professor John Henry Poynting, F.R.S., for his researches in physical science, especially in connection with the constant of gravitation and the theories of electrodynamics and radiation.

A Royal medal to Professor Charles Scott Sherrington, F.R.S., for his researches on the central nervous system, especially in relation to reflex action.

The Davy medal to Professor Albert Ladenburg, of Breslau, for his researches in organic chemistry, especially in connection with the synthesis of natural alkaloids.

The Hughes medal to Professor Augusto Righi, of Bologna, on the ground of his experimental researches in electrical science.

MEETING OF TRUSTEES OF THE CARNEGIE FOUNDATION.

THE first meeting of the trustees of the Carnegie Foundation, the $10,000,000 fund given by Mr. Andrew Carnegie last May for the pensioning of college professors, was held, on November 15, at Mr. Carnegie's residence, in New York.

The morning session was devoted to an informal conference. After luncheon Mr. Carnegie called the meeting formally to order. In a brief speech he expressed satisfaction at gathering together so many prominent educators. Nothing he had ever done, he said, seemed so propitious or so likely to be useful to the cause of education as this gift. He expressed the hope, in conclusion, that the trust would be administered in a broad and generous manner. President Eliot, of Harvard, in reply expressed the thanks of the teaching profession to the donor.

The board of directors organized by electing President Eliot chairman, President Harper vice-chairman and President Thwing secretary. By-laws were then adopted providing that the business of the board be entrusted to an executive committee and a president who shall be chairman of the committee. Dr. Henry S. Pritchett, president of the Massachusetts Institute of Technology, was chosen president. The committee was made up as follows: President Butler, of Columbia; President Wilson, of Princeton; Provost Harrison, of the University of Pennsylvania; President Humphreys, of Stevens Institute; Mr. Vanderlip, vice-president of the National City Bank; and Mr. Franks, Mr. Carnegie's financial secretary.

It was decided that the head office of the foundation shall be in New York City. The third Wednesday in November was selected as the date of the annual meeting. A special meeting will be held in New York late in the winter, at which time the executive committee will make a report on the plan and scope of the organization.

All the trustees except President Harper, of Chicago, were present, namely: Charles W. Eliot, Harvard; A. T. Hadley, Yale; Nicholas Murray Butler, Columbia; Woodrow Wilson, Princeton; Jacob G. Schurman, Cornell; L. Clark Seeley, Smith; Charles C. Harrison, Pennsylvania; Alexander C. Humphreys, Stevens Institute; S. B. McCormick, Western University of Pennsylvania; Edwin B. Craighead, Tulane; H. C. King, Oberlin; Edwin H. Hughes, De Pauw; C. F. Thwing, Western Reserve University; Thomas McClelland Bell, Drake; George H. Denny, Washington and Lee; Principal Peterson, McGill University, Montreal; Samuel Plautz, Lawrence; David Starr Jordan, Stanford; W. H. Crawford, Allegheny; Henry S. Pritchett, Massachusetts Institute of Technology; F. A. Vanderlip, T. Morris Carnegie and Robert A. Franks.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR ALBERT VON KÖLLICKER, the eminent anatomist and zoologist, died at Würzburg, on November 3, at the age of eighty-eight years.

AT the meeting of the Academy of Natural Sciences of Philadelphia, held on November 7, the Hayden memorial gold medal was unanimously voted to Charles Doolittle Walcott, director of the United States Geological Survey, in recognition of the value of his individual contributions to geological science and of the benefits derived from his able and con-

scientious discharge of the official trust confided to him.

THE daily papers announce that the Mexican Astronomical Society has awarded the prize offered by the Bishop of Leon for some notable astronomical discovery to William H. Pickering, of Harvard College Observatory, for the discovery of the tenth satellite of Saturn. Another prize was awarded to Professor C. D. Perrine, of Lick Observatory, California, for the discovery of the sixth and seventh satellites.

THE French Academy of Moral and Political Sciences has decided to award the François-Joseph Audiffred prize, of the value of $3,000, which is given in recompense of the most beautiful and greatest acts of self-devotion of whatever kind they may be, to Professor Calmette, director of the Pasteur Institute at Lille.

MEDICAL journals state that medals were awarded by the recent Congress of Tuberculosis to Drs. Koch, of Berlin; Brouardel, of Paris; Bang, of Copenhagen; Biggs, of New York; Broadbent, of London; and von Schroetter, of Vienna.

PRESIDENT ELIOT, of Harvard University, gave, on November 13, the first lecture under the foundation recently given to Yale University by a Harvard alumnus 'to promote friendly feelings between the two universities.' Dr. Eliot spoke on 'Resemblances and Differences among American Universities.'

DR. LEWELLYS F. BARKER, professor of medicine in the Johns Hopkins University, delivered an address before the Library and Historical Society of the University of Maryland, Baltimore, October 26, on 'The Ordering of Life.'

PROFESSOR K. KLEIN has been appointed director of the Museum of Natural History of the University of Berlin, in which position he succeeds Dr. Karl Möbius.

MR. G. W. SMITH, New College, Oxford, has been appointed to the biological scholarship at Naples for the year 1905–6.

DR. MAURITS SNELLIN has resigned the directorship of the section of terrestrial magnetism and seismology at the Royal Dutch Meteorological Institute.

SIR FREDERICK TREVES, the well-known surgeon, has agreed to be nominated on non-political and academic grounds for the lord rectorship of Aberdeen University.

DR. JOHN DYNELEY PRINCE, professor of Semitic languages and literature in Columbia University, has been elected to the New Jersey State Assembly from Passaic County.

WE learn from the *British Medical Journal* that King Edward on the occasion of his birthday has conferred the honor of knighthood upon Dr. James Barr, physician to the Royal Infirmary, Liverpool, and lecturer on clinical medicine in University College, Liverpool, and upon Mr. Arthur Chance, president of the Royal College of Surgeons in Ireland. Dr. Theodore Thomson, one of the medical inspectors of the Local Government Board, has been made a C.M.G. in recognition of services rendered in connection with sanitary matters to the Foreign Office and Colonial Office. The same honor is conferred upon Dr. Marc Armand Ruffer, president of the Egyptian Sanitary Board, distinguished for his researches in bacteriology and pathology; and upon Dr. Featherston Cargill, resident in the Protectorate of Northern Nigeria. Sir Felix Semon, C.V.O., physician extraordinary to the king, has been advanced to be a knight of the Royal Victorian Order. The honor of knighthood has also been conferred upon Mr. John McFadyean, professor of comparative pathology and bacteriology, Royal Veterinary College, London.

AT a recent meeting of the directors of the Christian Association of the University of Pennsylvania it was resolved to send Dr. Josiah C. McCracken to China for a period of one year in order to study the situation on the field and arrange details for the establishment of the proposed medical school in Canton.

DR. C. H. GORDON, until recently professor of geology in the New Mexico School of Mines, has been engaged for several months in the study of the geology and ore occur-

rences of the Magdalena and Black Range districts of New Mexico for the U. S. Geological Survey.

PROFESSOR G. F. HULL, of Dartmouth College, is spending the year at the Cavendish Laboratory, Cambridge. He has been elected fellow commoner by the council of St. John's College.

DR. SVEN HEDIN is on the way to Persia, where he proposes to explore thoroughly, from a scientific point of view, the salt deserts of Dasht-i-Kavir and Dasht-i-Lut in the eastern part of the country. He hopes afterwards to proceed through Afghanistan to India, and there organize an expedition for the exploration of Central Tibet.

Nature states that at the inaugural meeting of the eighty-seventh session of the Institution of Civil Engineers, held on Tuesday, November 7, Sir Guilford Molesworth, K.C.I.E., the retiring president, formally introduced to the members his successor in the chair, Sir Alexander Binnie, who delivered an address to the members, in which he traced the influence of scientific thought and investigation upon the development of engineering practise.

SIR ARCHIBALD GEIKIE expected, on behalf of the board of geographical studies, of Cambridge University, to deliver a public lecture in the Sedgwick Museum, on November 21, on 'The Evolution of a Landscape.'

PROFESSOR GEORGE M. STRATTON, of the Johns Hopkins University, lectured last week before the department of philosophy, of Wesleyan University, on 'Optimism and the Scientific Method.'

A PUBLIC meeting on the mosquito question was held at the Johns Hopkins University, Baltimore, on November 1, at which Professor John B. Smith, state entomologist of New Jersey, delivered an illustrated lecture.

AN oil portrait of Dr. John Rodman Coxe, was presented, by his grandson, to the department of medicine of the University of Pennsylvania, on October 20. In 1809 Dr. Coxe was appointed professor of chemistry in the University of Pennsylvania, and from 1818 to 1835 he was professor of materia medica and pharmacy. He was a trustee of the university and one of the founders of the Philadelphia College of Pharmacy.

DR. F. A. MÜLLER, formerly professor in the veterinary institute of the University of Vienna, died on October 16 at the age of eighty-nine years.

THE death is also announced of Professor Albert Engelbrecht, of the Government Laboratory for Chemistry, at Hamburg.

WE learn from *Nature* that at a meeting of the council of the British Association on November 3, it was decided that, in consequence of representations by the local committee, the meeting at York next year shall be opened on Wednesday, August 1, which is earlier than the usual date. The council of the association has received a gift of £50 from Mrs. John Hopkinson, to be devoted to some investigation which may be suggested at the next meeting by the committee of recommendations.

THE fourth meeting of the California Branch of the American Folk-Lore Society was held at the University of California in Berkeley, on Tuesday, November 14. Professor John Fryer delivered a lecture on 'Fox-Myths in Chinese Folk-Lore,' illustrated by specially prepared lantern slides.

THERE will be a New York State civil service examination on December 9, when positions will be filled of assistant chemist in the Cancer Laboratory at Buffalo, with a salary of $720; for physician in the State Hospitals, beginning at an annual salary of $900 and increasing to $1,200 with maintenance, and of assistant statistician in the Department of Excise, with a salary of $1,500 to $1,800.

A TELEGRAM has been received at the Scottish National Antarctic offices in Edinburgh from Mr. Angus Rankin, announcing the arrival of the Ben Nevis Observatory staff at Buenos Ayres, from which place they leave shortly for the Antarctic station at Scotia Bay, South Orkneys.

THE British registrar-general has issued his returns relating to the births and deaths in the

third quarter of the year. According to the abstract in the *British Medical Journal,* the births registered in England and Wales during the quarter ending September last numbered 235,205, and were equal to an annual rate of 27.3 per 1,000 of the population, estimated at 34,152,977 persons in the middle of the year. This is the lowest birth rate recorded in the third quarter of any year since civil registration was established, and was 1.8 per 1,000 below the average in the corresponding quarters of the ten preceding years, 1895–1904. Among the several registration counties the birth rate last quarter ranged from 21.3 in Sussex, 22.6 in Herefordshire, 22.8 in Dorsetshire and in Cornwall, and 22.9 in Somersetshire, to 30.8 in Nottinghamshire, 32.2 in Northumberland, 32.6 in Carmarthenshire, 34.1 in Durham, 34.6 in Glamorganshire, and 35.7 in Monmouthshire. In seventy-six of the largest English towns, including London, the birth rate averaged 28.2 per 1,000; in London the rate was 26.8. During the third quarter of the year the deaths of 120,792 persons were registered, equal to an annual rate of 14.0 per 1,000; this rate was 2.5 per 1,000 below the mean rate in the corresponding periods of the ten preceding years. The lowest county death rates last quarter were 10.3 in Surrey and in Hertfordshire, 10.5 in Berkshire, 10.6 in Bedfordshire, 10.7 in Dorsetshire, and 10.8 in Cambridgeshire; the highest rates were 15.1 in the East Riding of Yorkshire, 15.9 in Glamorganshire, 16.1 in Northumberland and in Monmouth, 16.8 in Lancashire, and 17.1 in Durham. In seventy-six of the largest English towns, with an aggregate population of more than fifteen and a half millions, the mean rate of mortality was 15.2 per 1,000; in 141 smaller towns, containing in the aggregate about four and three quarter millions of persons, the rate averaged 13.3 per 1,000; while in the remaining, and chiefly rural parts of England and Wales the rate was 13.0 per 1,000. In London the death rate was 14.6 per 1,000. The rate of infant mortality, measured by the proportion of deaths among children under 1 year of age to registered births, was equal to 155 per 1,000, against an average rate of 192. In the several counties the rates of infant mortality ranged from 61 in Cambridgeshire, 64 in Dorsetshire, 68 in Somersetshire, 70 in Buckinghamshire, 75 in Hertfordshire, and 76 in Shropshire, to 176 in Glamorganshire, 182 in the West Riding of Yorkshire, 186 in Durham, and 200 in Lancashire and in the East Riding of Yorkshire. In the seventy-six large towns the mean rate was 186 per 1,000; in London the proportion was equal to 174 per 1,000, while it averaged 191 in the seventy-five large provincial towns, among which the rates ranged from 74 in Hornsey, 75 in Bournemouth, 77 in King's Norton, 88 in Burton-on-Trent, and 89 in Hastings, to 261 in Sheffield, 267 in Wigan, 275 in Norwich, 277 in Stockport, 282 in Rhondda, and 354 in Grimsby.

UNIVERSITY AND EDUCATIONAL NEWS.

BY the will of Joseph E. Gillingham, numerous bequests are made to educational and charitable institutions, including $50,000 each to the University of Pennsylvania for the veterinary department, to Haverford College, to Swarthmore College and to Bryn Mawr College.

THE trustees of the agricultural school, provided for in the will of Oliver Smith, of Hatfield, sixty years ago, have bought a site in Northampton, Mass., in order to be ready for establishing the school when the funds become available on December 22. The purchase consists of ninety-three acres, obtained for $19,450. The endowment now amounts to $312,000.

THE school fund of Minnesota now amounts to over $16,000,000, and is increasing at the rate of a million dollars a year. It is said that this fund, which by the constitution of the state accrues from the sale of certain lands, will ultimately amount to $100,000,000, only the interest of which can be used for school purposes.

BY the will of the late Mr. J. E. Williams, the University of Wales receives £10,000 and the University College of North Wales at Bangor £12,000.

THE council of University College, Dundee, have declined Mr. J. K. Caird's gift of £16,000 for the erection of a physical laboratory on

the college grounds, judging Mr. Caird's conditions to harmonize neither with the needs of the college nor with the general plan of building construction.

The tenth annual meeting of the National Association of State Universities began at Washington, D. C., on November 13, with thirty-two presidents of state universities present. The session was devoted to the annual address of Chancellor E. Benjamin Andrews, of the University of Nebraska, president of the association, and to a discussion of the attitude state universities should take toward graduate work.

The new chemistry building of the University of Wisconsin, which has been in the course of construction during the past year, has been completed and is now ready for occupancy. The building is completely equipped with apparatus for the study of all branches of the subject, including electrical, physical and pharmaceutical chemistry. The auditorium on the main floor will accommodate between 500 and 600 students, and the laboratory for general chemistry which adjoins it has 540 individual working desks. Smaller research laboratories for graduate and advanced students, a laboratory for inorganic chemistry, and the offices of the professors of the department, occupy the remainder of the first floor. Two large laboratories for analytical chemistry, the department library and two lecture rooms constitute the second floor. On the third floor are placed the laboratories for pharmaceutical, physical and electrical chemistry, and the office and laboratory of the state chemist. The old chemical laboratory on the shore of Lake Mendota has been remodeled for the departments of chemical engineering and assaying. The quarters in North Hall formerly occupied by the department of pharmacy have been remodeled and are now occupied by the department of commerce. Besides lecture and class rooms, a portion of the hall has been set aside for the new commercial museum, which is rapidly being arranged for the use of the commerce students.

The number of students registered this term at Cambridge University is 1,008, distributed as follows: King's, 56; Trinity, 200; St. John's, 66; Peterhouse, 12; Clare, 61; Pembroke, 76; Gonville and Caius, 86; Trinity Hall, 44; Corpus Christi, 21; Queen's, 10; St. Catharine's, 15; Jesus, 57; Christ's 46; Magdalene, 15; Emmanuel, 76; Sidney Sussex, 27; Downing, 32; Selwyn Hostel, 39; non-collegiate, 39.

Dr. Herbert Moody has been appointed assistant professor in analytic chemistry at the College of the City of New York. He is a graduate of the Massachusetts Institute of Technology, and for four years was instructor there.

The committee for the supervision of instruction in geography at Oxford has appointed Dr. A. J. Herbertson, director of the school of geography, for the remainder of the term of five years for which the grants to the school of geography have been voted.

At Manchester University, Mr. C. G. Hewitt, B.Sc. (Man.), has been appointed assistant lecturer and demonstrator in zoology; and Mr. A. Stephenson, B.Sc. (Wales), lecturer in the Technical College, Sunderland, assistant lecturer in mathematics.

The council of King's College has made the following appointments: Mr. E. P. Harrison, Ph.D., and Mr. H. S. Allen, M.A., B.Sc., assistant lecturers in physics; Mr. C. F. Russell, B.A., assistant lecturer in mathematics; Mr. L. Hinkel, assistant demonstrator in chemistry; Mr. W. Woodland, demonstrator in zoology; Mr. O. S. Sinnatt, B.Sc., and Mr. R. Wolfenden, B.Sc., demonstrators in engineering; Mr. J. E. S. Frazer, F.R.C.S., transferred from St. George's Hospital to King's College as demonstrator in anatomy.

Dr. René du Bois-Reymond has been appointed head of the department for special physiology in the physiological laboratory of the University of Berlin, in succession to the late Professor P. Schultz.

Dr. G. Hellmann, chief of department in the Royal Meteorological Institute in Berlin, has been appointed professor in the university. A department library and reading room has also been provided.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, DECEMBER 1, 1905.

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE LOGICAL BASIS OF THE SANITARY POLICY OF MOSQUITO REDUCTION.[1]

THE great science of preventive medicine is often called upon to consider new policies of public sanitation, which, whether they ultimately prove successful or not, are always of profound interest and importance to mankind. Quite recently a new measure of this kind has been proposed, which in the opinion of many promises to rank with house sanitation and preventive inoculation as a means of saving human life on a large scale. Unfortunately, its value has not yet been clearly demonstrated—with the result that it is not being employed as largely as some of us hoped would be the case. I feel, therefore, that I can not better acknowledge the honor you have done me in inviting me to address you to-day than by attempting to discuss this important theme—in the hope that the discussion may prove profitable to the cause of public health. The new sanitary policy to which I refer is that which aims at the reduction of disease-bearing insects, especially those which are the disseminating agents of malaria, yellow fever and filariasis.

I presume that it is scarcely necessary to discuss the evidence which has established the connection between various insects and arthropods and many diseases of man and of animals. The fact that the pathogenetic parasites which produce those great scourges of the tropics just mentioned are carried by gnats is now too well known to require reiteration. It is necessary only to

[1] Read at the International Congress of Arts and Science.

remind you that the gnat acts as an intermediary, becoming infected when biting infected persons and, some weeks later, infecting healthy persons in its turn—the parasite passing alternately from insect to man. The hypothesis that the infection in these diseases may be produced in any other manner than by the bite of gnats has not been justified by any recorded experiments or by any substantial arguments; and we may, therefore, assume for the present that if we could exterminate the intermediary agents, the gnats, in a locality, we could also exterminate there the diseases referred to. But here we enter upon ground which in the opinion of many is much less secure. While some believe in the possibility of reducing gnats in given localities and consider that the point has been proved by experiment, others are much more sceptical and hold that the experiments were not sound. This state of uncertainty naturally causes much hesitation in the adoption of measures against gnats, and, therefore, possibly a continued loss of life by the diseases occasioned by them; and I, therefore, propose to sift the matter as carefully as time will allow.

In the first place, we should note that experiments made in this connection have not been very satisfactory, owing to the fact that no accurate method has yet been found for estimating the number of gnats in any locality. We can express our personal impressions as to their numbers being small or large; but I am aware of no criterion by which we can express those numbers in actual figures. We can not anywhere state the exact number of mosquitoes to the square mile or yard, and we can not, therefore, accurately gauge any local decrease which may have resulted from operations against them. A method of doing this may be invented in the future; but for the present we must employ another means for resolving the problem—one which has given such great results in physics—namely, strict logical deduction from ascertained premises.

As another preliminary we should note that mosquito-reduction is only part of a larger subject, namely, that of the local reduction of any living organisms. Unlike particles of matter (so far as we know them) the living unit can not progress through space and time for more than a limited distance. The diffusion of living units must, therefore, be circumscribed—a number of them liberated at a given point will never be able to pass beyond a certain distance from that point; and the laws governing this diffusion must be the same for all organisms. The motile animal is capable of propelling itself for a time in any direction; but even the immotile plant calls in the agency of the winds and waters for the dissemination of its seeds. The extent of this migration, whether of the motile or the immotile organism, must to a large degree be capable of determination by proper analysis; and the logical position of the question of local reduction depends upon this analysis.

The life of gnats, like that of other animals, is governed by fixed laws. Propagation can never exceed, nor mortality fall below, certain rates. Local conditions may be favorable either to the birth rate or to the death rate; and the local population must depend upon the food supply. Diseases, predatory animals, unfavorable conditions and accidents depress the density of population; and in fact local reduction, that is, artificial depression of the density of population, practically resolves itself into (*a*) direct destruction and (*b*) artificial creation of unfavorable conditions.

Let us now endeavor to obtain a perfectly clear picture of the problem before us by imagining an ideal case. Suppose that we have to deal with a country of indefinite extent, every point of which is

equally favorable to the propagation of gnats (or of any other animal); and suppose that every point of it is equally attractive to them as regards food supply; and that there is nothing, such for instance as steady winds or local enemies, which tends to drive them into certain parts of the country. Then the density of the gnat population will be uniform all over the country. Of course, such a state of things does not actually exist in nature; but we shall nevertheless find it useful to consider it as if it does exist, and shall afterwards easily determine the variations from this ideal condition due to definite causes. Let us next select a circumscribed area within this country, and suppose that operations against the insects are undertaken inside it, but not outside it. The question before us is the following: How far will these operations affect the mosquito density within the area and immediately around it?

Now the operations may belong to two categories—those aimed at killing the insects within the area, and those aimed at checking their propagation. The first can never be completely successful; it is in fact impossible to kill every adult winged gnat within any area. But it is generally possible to destroy at least a large proportion of their *larvæ,* which, it is scarcely necessary to remind you, must live for at least a week in suitable waters, and which may easily be killed by larvacides, or by emptying out the waters, or by other means. This method of checking propagation consists, in the case of these insects, of draining away, filling up, poisoning or emptying out the waters in which they breed. Obviously the ultimate effect is the same if we drain away a breeding pool or if we persistently destroy the larvæ found in it; though in the first case the work is more or less permanent, and in the second demands constant repetition. If we drain a breeding area we tend to produce the same effect at the end of a year as if we had destroyed as many gnats as otherwise that area would have produced during that period. Thus, though we can not kill all mosquitoes within an area, even during a short period, we can always arrest their propagation there for as long as we please, provided that we can obliterate all their breed waters or persistently destroy all their larvæ—which we may assume can generally be done for an adequate expenditure. We must, therefore, ask what will be the exact effect of completely arresting propagation within a given area under the assumed conditions?

The first obvious point is that the operation must result in a decrease of mosquitoes. If we kill a single gnat there must be one gnat in the world less than before. If we kill a thousand every day there must be so many thousands less at the end of a given period; and the arrest of propagation over any area, however small, must be equivalent to the destruction of a certain number of the insects. But this does not help us much. It may be suggested that, after the arrest of propagation over even a considerable area, the diminution of mosquitoes within the area remains inappreciable. What is the law governing the percentage of diminution in the mosquito density due to arrest of propagation within an area?

The number of gnats (or any animal) within an area must always be a function of four variables, the birth rate and death rate within the area, and the immigration and emigration into and out of it. If we could surround the area by an immense mosquito bar, the insects within it (after the death of old immigrants) would consist entirely of native insects; on the other hand, if we arrest propagation, the gnat population must hereafter consist entirely of immigrants. The question, therefore,

resolves itself into this one: What is—what must be—the ratio of immigrants to natives within any area? What factors determine that ratio?

Ceteris paribus, one factor must be the size of the area. If the area be a small one, say of ten yards radius, suppression of propagation will do little good, because the proportion of mosquitoes bred there will be very small (under our assumed conditions) compared with those which are bred in the large surrounding tracts of country, and which will have no difficulty in traversing so small a distance as ten yards. But if we completely suppress propagation over an area of ten miles radius, the case must be very different—every gnat reaching the center must now traverse ten miles to do so. And if we increase the radius of the no-propagation area still further, we must finally arrive at a state of affairs when no mosquitoes at all can reach the center, and when, therefore, that center must be absolutely free from them. In other words, we can reduce the mosquito density at any point by arresting propagation over a sufficient radius around that point.

But we now enter upon more difficult ground. How large must that radius be in order to render the center entirely mosquito-free? Still further, what will be the proportion of mosquito reduction depending upon a given radius of anti-propagation operations? What will be that proportion, either at the center of operations, or at any point within or without the circumference of operations? The answer depends upon the distance which a mosquito can traverse, not during a single flight, but during its whole life; and also upon certain laws of probability, which must govern its wanderings to and fro upon the face of the earth. Let me endeavor to indicate how this problem, which is essentially a mathematical one of considerable interest, can be solved.

Suppose that a mosquito is born at a given point, and that during its life it wanders about, to and fro, to left or to right, where it wills, in search of food or of mating, over a country which is uniformly attractive and favorable to it. After a time it will die. What are the probabilities that its dead body will be found at a given distance from its birthplace? That is really the problem which governs the whole of this great subject of the prophylaxis of malaria. It is a problem which applies to any living unit. We may word it otherwise, thus—suppose a box containing a million gnats were to be opened in the center of a large plain, and that the insects were allowed to wander freely in all directions—how many of them would be found after death at a given distance from the place where the box was opened? Or we may suppose without modifying the nature of the problem that the insects emanate, not from a box, but from a single breeding pool.

Now what would happen is as follows: We may divide the career of each insect into an arbitrary number of successive periods or stages, say of one minute's duration each. During the first minute most of the insects would fly towards every point of the compass. At the end of the minute a few might fly straight on and a few straight back, while the rest would travel at various angles to the right or left. At the end of the second minute the same thing would occur—most would change their course and a very few might wander straight on (provided that no special attraction exists for them). So also at the end of each stage—the same laws of chance would govern their movements. At last, after their death, it would be found that an extremely small proportion of the insects have moved continuously in one direction, and that the vast majority of them

have wandered more or less backward and forward and have died in the vicinity of the box or pool from which they originally came.

The full mathematical analysis determining the question is of some complexity; and I can not here deal with it in its entirety. But if we consider the lateral movements as tending to neutralize themselves, the problem becomes a simple one, well known in the calculus of probabilities and affording a rough approximation to the truth. If we suppose that the whole average life of the insect contains n stages, and that each insect can traverse an average distance l during one such stage or element of time, then the extreme average distance to which any insect can wander during the whole of its life must be nl. I call this the limit of migration and denote it by L, as it becomes an important constant in the investigation. It will then be found that the numbers of insects which have succeeded in reaching the distances nl, $(n-1)l$, $(n-2)l$, etc., from the center will vary as twice the number of permutations of $2n$ things taken successively, none, one, two, three at a time, and so on—that is to say, as the successive coefficients of the expansion of 2^{2n} by the binomial theorem. Suppose, for convenience, that the whole number of gnats escaping from the box is 2^{2n}—a number which can be made as large as we please by taking n large enough and l small enough—then the probabilities are that the number of them which succeed in reaching the limit of migration is only 2; the number of those which succeed in reaching a distance one stage short of this, namely, $(n-1)l$, is $2.2n$ of those which reach a stage one shorter still is

$$2\frac{2n(2n-1)}{2!}$$

and so on. Hence the whole number of gnats will be found arranged as follows:

Distance from center	nl	$(n-1)l$	$(n-2)l$	$(n-3)l$	etc.	total.
Number of gnats	$2+$	$4n$	$+2\frac{2n(2n-1)}{2!}$	$+2\frac{2n(2n-1)(2n-2)}{3!}$	$+$ etc.	$=2^{2n}$.

It, therefore, follows from the known values of the binomial coefficients that if we divide the whole number of gnats into groups according to the distance at which their bodies are found from the box, the probabilities are that the largest group will be found at the first stage, that is, close to the box, and that the successive groups, as we proceed further and further from the box, will become smaller and smaller, until only a very few occur at the extreme distance, the possible limit of migration. And the same reasoning will apply to a breeding pool or vessel of water. That is, the insects coming from such a source will tend to remain in its immediate vicinity, provided that the whole surrounding area is uniformly attractive to them.

The following diagram will, I hope, make the reasoning quite clear.

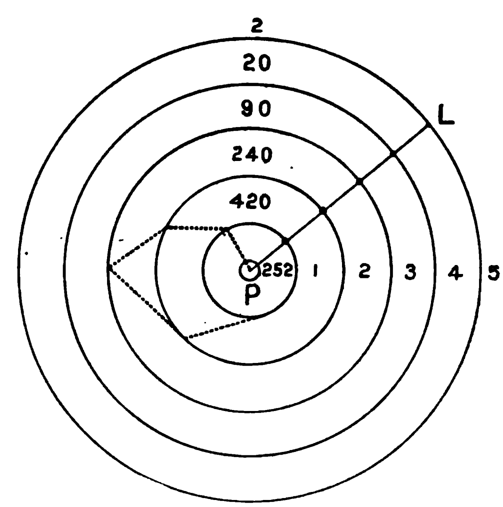

DIAGRAM I. The chance-distribution of Mosquitoes. P, central breeding-pool. L, limit of migration. The numbers denote the proportions of 1,024 mosquitoes starting from P which die at the distances 1, 2, 3, 4, 5, respectively. The continuous line denotes a continuous migration always in one direction; the dotted line, the usual erratic course.

We suppose that 1,024 mosquitoes have escaped during a given period from the central breeding-pool P, and we divide their subsequent life into 5 stages—the numbers 1,024 and 5 being selected merely for illustration. Rings are drawn around the central pool in order to mark the distance to which the insects may possibly wander up to the end of each stage; and the continuous line shows the course followed by one which has wandered straight onward all its life and has died at the extreme limit to which an insect of its species can generally go, namely, the outermost circle, L. On the other hand, the dotted line shows a course which is likely to be followed by the largest number of the 1,024 insects liberated from the pool—that is to say, a quite irregular to-and-fro course, generally terminating somewhere near the point of origin. The numbers placed on each ring show the number of mosquitoes calculated from the binomial coefficients when $n = 5$, which are likely to reach as far as that ring at the time of their death. Thus only 2 out of the 1,024 mosquitoes are ever likely to reach the extreme limit; while, on the other hand, no less than 912, or 89 per cent., are likely to die somewhere within the second ring around the center.

The same reasoning will apply whatever may be the number of mosquitoes liberated from the pool, or the number of stages into which we arbitrarily divide their subsequent life. Suppose, for example, that 1,048,576 mosquitoes escape from the pool and that we divide their life into 10 stages. Then only two of all these insects are ever likely to reach the extreme limit of the outermost circle; only 40 will die at the next circle; only 190 at the next; and so on—the large majority perishing within the circles comparatively close to the point of origin.

This fact should be clearly grasped. The law here enunciated may, perhaps, be called *the centripetal law of random wandering*. It ordains that when living units wander from a given point *guided only by chance* they will always tend to revert to that point. The principle which governs their to-and-fro movements is that which governs the drawing of black and red cards from a shuffled pack. The chances against our drawing all the twenty-six black cards from such a pack without a single red card amongst them are enormous; as are the chances against a mosquito, guided only by chance, always wandering on in one direction. On the other hand, just as we shall generally draw black and red cards alternately from the pack, or nearly so, so will the random movements of the living unit tend to be alternately backward and forward—tend, in fact, to keep it near the spot whence it started. As there is no particular reason why it should move in one direction more than another, it will generally end by remaining near where it was.

But it will now be objected that the movements of mosquitoes are not guided only by chance, but by the search for food. To study this point, take the diagram just given, place a number of pencil dots upon it at random, and suppose that each pencil dot denotes a place where the insects can obtain food—suppose, for example, that the breeding pool lies in the center of a large city and that the pencil dots are houses around it. Consideration will show that the centripetal law must still hold good, because there is no reason why the insects should attack one house more than another. There is no reason why a mosquito which has flown straight from the pool to the nearest house should next fly to another house in a straight line away from the pool, rather than back again, or to the right or left. The same law of chance will continue to exert the same in-

fluence, and the insects will always tend to persecute most those houses which lie in the immediate vicinity of their breeding pool. Even when there are many pools scattered about among the houses, there is no reason why, after feeding, the mosquitoes will go to one rather than to another; and the result must be that in general they will tend to remain where they were.

Self-evident as this argument may now appear, it is not understood by many who write on the subject and who seem to think that mosquitoes radiate from a center and shoot forever onward into all parts of the country as rays of light do. Accepting this fallacy without question, they argue that it is useless to drain local breeding pools because of the influx of mosquitoes from without. Such an influx certainly always exists; but I shall now endeavor to show that it can not generally compensate for local destruction.

Let us consider a tract of country over which numbers of mosquito-breeding pools are scattered, with houses and other feeding places lying among them. Suppose we draw a straight line across this country and drain away all the pools to the right of it, leaving all those to the left of it intact. Then all the insects on the left of the line must be natives of that part; and all those on the right of it must be immigrants which have crossed over the line from the left. How many mosquitoes will there now be on the right side, compared with those on the left side? The following diagram will enable us to consider this question more conveniently.

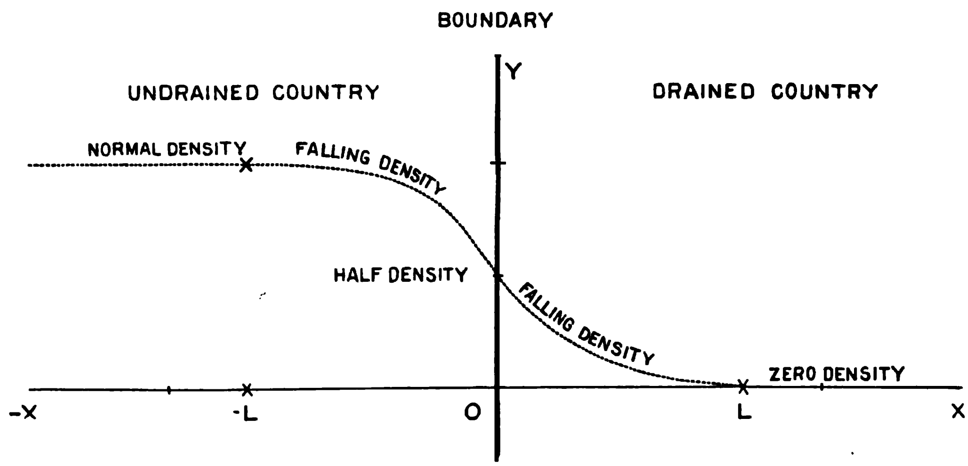

Diagram II. Curve of falling mosquito-density due to drainage on right of boundary. *L* and *-L* are the limit of migration on either side of the boundary.

First, examine the state of affairs before the drainage was effected. We may suppose that mosquitoes were then breeding fairly uniformly over the whole country, and that their density was much the same on both sides of the line. A certain amount of migration across the line, both from right to left and from left to right, must always have been going on; and since the density was equal on both sides, this migration must also have been *equal and opposite*—that is, as many emigrants must have been constantly passing from right to left as from left to right. Now, after the drainage has been effected, the following changes occur. The insects breed as before on the left of the line, and some con-

tinue as before to cross over it into the drained country; but, in the latter, on the right of the line, propagation is entirely checked and, moreover, the migration from it to the left of the line, which used to exist, now ceases. Hence not only must there be a decrease of mosquito-density on the right of the line, due to the local cessation of breeding, but also a decrease on the left of the line, due to the cessation of the migration from the right which formerly took place—that is to say, the drainage has affected the mosquito-density not only up to the line of demarcation, but beyond it. And moreover, since the migration was formerly equal from both sides of the line, it follows that now, after the drainage, the loss on the left side of the line due to the cessation of immigration from the right is exactly equal to the gain on the right due to the continuance of the immigration from the left. That is to say, the mosquitoes gained by immigration into the drained country must be exactly lost by the undrained country. This fact can be seen to be obviously true if we imagine an immense mosquito bar put up along the line of demarcation so as to check all migration across it, when, of course, the mosquito-density would remain as at first on the left, and would become absolute zero on the right: then on removing the mosquito-bar an overflow would commence from left to right, which would increase the density on the right by exactly as much as it would reduce the density on the left.

The dotted line on the diagram indicates the effect on the mosquito-density which must be produced by the drainage. If L is the possible limit of migration of mosquitoes (it may be one mile or a hundred, for all we know), the effect of the drainage will first begin to be felt at that distance to the left of the boundary line. From this point the density will begin to fall gradually until the boundary is reached, when it must be *exactly one half the original density*. This follows because of the equivalence of the emigration and immigration on the two sides. Next, as we proceed from the boundary into the drained country, the density continues to fall, until at a distance L on the right of the line, it becomes zero, the country now becoming entirely free of mosquitoes because they can no longer penetrate so far from the undrained country.

In the diagram the line giving the mosquito-density falls very slowly at first, and then, near the boundary, very rapidly, subsequently sinking slowly to zero. The mathematical analysis on which this curve is based is too complex to be given here; but it is not difficult to see that the centripetal law of random migration must determine some such curvature. The mosquitoes which are bred in the pools lying along the boundary line must remain for the most part in its proximity, only a few finding their way further into the drained country, and only a very few reaching, or nearly reaching, the limit of migration. Though an infinitesimal proportion of them may wander as far as ten, twenty or more miles into the drained country (and we do not know exactly how far they may not occasionally wander) the vast bulk of the immigrants must remain comparatively close to the boundary. And as, for the reason just given, the mosquito-density on the boundary itself must always be only one half the original density, it follows that it must become very rapidly still less, the further we proceed into the drained country. In fact, the analysis shows that the total number of emigrants must be insignificant when compared with the number of insects which remain behind—that is, when they are not drawn particularly in one direction. We are, therefore, justified

in concluding that, as a general rule, the number of immigrants into any area of operations must, for practical purposes, be very small or inappreciable a short distance within the boundary line. The following diagram probably represents with accuracy the effects of thorough suppression of propagation within a circular area.

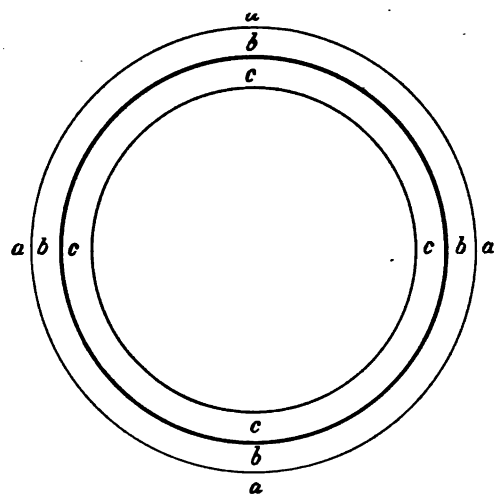

DIAGRAM III. Effect of drainage of a circular area. b = boundary of drained area. Mosquito-density begins to diminish at the circle a; becomes one half at the boundary b; and is small, inappreciable or zero at the circle c.

At the circle (a) and beyond it the mosquito density will be the normal density which existed before the operations were commenced. At (b), the circle bounding the drainage operations, the density will always be about half the normal density. At the circle (c) and within it, the density will be small, inappreciable or zero. The distance from (a) to (b) may be taken as being the same as that from (b) to (c); and, as the mosquitoes penetrating from (b) to (c) must be drawn from the zone between (a) and (b), the *average* result will be the same as if no immigration at all takes place. We do not possess sufficient data to enable us to calculate the actual distance between (a), (b) and (c)—this will depend in a certain measure on the activity of the species of insect concerned and on the existence or absence of special local attractions; but this fact does not discredit the general principles involved.

One case has not yet been considered, namely, that in which there exists only a single feeding place in the whole tract of country—such, for instance, as a single house or group of houses situated in the midst of deserted swamps. In such a case the insects may be compelled to come from considerable distances—from as far as their senses are capable of guiding them—in search of food; and drainage operations carried on with a view to relieving such a house may, for all we know, have to be extended over miles. But such cases are not of great consequence, because drainage is seldom the appropriate measure for isolated dwellings, which can generally be protected at far less cost by means of gauze screens. Moreover, it is very doubtful whether feeding places for mosquitoes are ever so solitary as the case assumes. Where there is one dwelling there are generally many, scattered at various distances over the country; and the insects are known to feed on cattle, birds and other animals. For towns, where anti-mosquito measures are most demanded, our first assumed condition of uniform attractiveness must, as a rule, be the one in force; and in such cases the centripetal law will hold.

The effect of wind required examination. Theoretically, if the insects are supposed always to remain on the wing, wind blowing on a generating pool will merely have the effect of drifting the whole brood to a certain extent in one direction without changing the *relative* positions of the insects to each other. The result would be the same as indicated in Diagram I., except that the generating pool would now be eccentric. If a proportion of the insects

take shelter, the circles of Diagram I. would become ellipses with the generating pool as a focus. In such a case the wind, and especially devious winds, would have a distributive tendency; but it must be remembered that if the insects are scattered further apart their members at a given point must be reduced. A wind which blows mosquitoes into an area must blow others out of it. The net result of devious winds on a circular drained area would be that the mosquito-density is not so much reduced at the center, but is reduced to a greater distance outside the boundary circle —so that the average reduction remains the same. With a wind blowing continuously from one direction, the indication would be to extend the drainage further in that direction. Obviously, wind may scatter mosquitoes; but it can not create them, nor prevent the total average reduction due to anti-propagation measures, as some people seem to think. It is, however, very doubtful whether wind does not really drive or scatter mosquitoes to any great degree. In my experience they are extremely tenacious of locality. Thus *Anopheles* were seldom seen on Tower Hill, a low open hill in the middle of Freetown, Sierra Leone, although numerous generating pools existed a few hundred yards from the top, all around the foot of it, and the winds were often very strong. If a continuous wind can drive mosquitoes before it, then during the southwest monsoon in India they should be driven away from the west coast and massed towards the east coast; but I have never heard that they are at all less numerous on the west coast. I have often seen very numerous mosquitoes on bare coasts exposed to strong sea-breezes, as at Madras. As a rule, they seem to take shelter in the presence of a strong breeze. Instances of their being driven far by winds are frequently quoted, but in my opinion they were more probably bred, in many such cases, in unobserved pools close at hand. The wind-hypothesis is frequently used by municipal officials as an excuse for doing nothing—it is convenient to blame a marsh miles distant for propagating the mosquitoes which are really produced by faulty sanitation in the town itself.

Another and similar statement is often made with all gravity to the effect that mosquitoes are brought into towns in trains, carts and cabs. So they are; but a moment's reflection will assure us that the number introduced in this manner must always be infinitesimal compared with those that fly in or which are bred in the town itself. Moreover, if vehicles may bring them in they may also take them out.

I will now endeavor to sum up the arguments which I have laid before you—I fear very cursorily and inadequately. First I suggested that there must be for every living unit a certain distance which that unit may possibly cover if it continues to move all its life, with such capacity for movement as nature has given it, always in the same direction. I called this distance the limit of migration. It should, perhaps, be called the ideal limit of migration, because scarcely one in many billions of living units is ever likely to reach it—not because the units do not possess the capacity for covering the distance, but because the laws of chance ordain that they shall scarcely ever continue to move always in the same direction. Next I endeavored to show that, owing to the constant changes of direction which must take place in all random migration, the large majority of units must tend to remain in or near the neighborhood where they were born. Thus, though they may really possess the power to wander much further away, right up to the ideal limit, yet actually they always find themselves confined by the impalpable but no

less impassable walls of chance within a much more circumscribed area, which we may call the practical limit of migration—that is, a limit beyond which any given percentage of units which we like to select do not generally pass. Lastly I tried to apply this reasoning to the important particular case of the immigration of mosquitoes into an area in which their propagation has been arrested by drainage and other suitable means. My conclusions are:

1. The mosquito-density will always be reduced, not only within the area of operations, but to a distance equal to the ideal limit of migration beyond it.

2. On the boundary of operations the mosquito-density should always be reduced to about one half the normal density.

3. The curve of density will rise rapidly outside the boundary and will fall rapidly inside it.

4. As immigration into an area of operations must always be at the expense of the mosquito population immediately outside it, the average density of the whole area affected by the operations must be the same as if no immigration at all has taken place.

5. As a general rule for practical purposes, if the area of operations be of any considerable size, immigration will not very materially affect the result.

In conclusion, it must be repeated that the whole subject of mosquito-reduction can not be scientifically examined without mathematical analysis. The subject is really a part of the mathematical theory of migration—a theory which, so far as I know, has not yet been discussed. It is not possible to make satisfactory experiments on the influx, efflux and varying density of mosquitoes without such an analysis—and one, I may add, far more minute than has been attempted here. The subject has suffered much at the hands of those who have attempted ill-devised experiments without adequate preliminary consideration, and whose opinions or results have seriously impeded the obviously useful and practical sanitary policy referred to. The statement, so frequently made, that local anti-propagation measures must always be useless, owing to immigration from outside, is equivalent to saying that the population of the United States would remain the same, even if the birth rate were to be reduced to zero. In a recent experiment at Mian Mir in India the astounding result was obtained that the mosquito-density was, if anything, increased by the anti-propagation measures—which is equivalent to saying that the population of the United States would be increased by the abolition of the birth rate. It is to be hoped that if such experiments are to be repeated they will be conducted by observers who have considered the subject. In the meantime, I for one must continue to believe the somewhat self-evident theory that anti-propagation measures must always reduce the mosquito density—even if the results at Havana, Ismailia, Klang, Port Swettenham and other places are not accepted as irrefragable experimental proof of it.

RONALD ROSS.

THE LIVERPOOL SCHOOL OF TROPICAL MEDICINE.

SCIENTIFIC BOOKS.

A Text-Book of Physics: Heat. By J. H. POYNTING and J. J. THOMSON. London, Charles Griffin & Co. 1904. Pp. xvi + 354.

This text-book is the third of a series on general physics by the two distinguished scholars of Birmingham University and of Cambridge. The other two volumes are 'Properties of Matter,' which has already reached a second edition, and 'Sound,' the third edition of which has recently appeared. Two more volumes, on 'Light' and 'On Magnetism and Electricity,' are in preparation. As Professor Poynting says in the preface to

the volume before us, 'The text-book is intended chiefly for the use of students who lay most stress on the study of the experimental part of physics, and who have not yet reached the stage at which the reading of advanced treatises on special subjects is desirable.' With this end in view special attention is given the description of the fundamental experiments and special emphasis is laid upon the various assumptions, and the conditions under which the different theories hold.

It is of interest to note the order of arrangement of the matter in a text-book written by men so well known as teachers as well as investigators. There are in all twenty chapters, and their contents may be outlined as follows: Discussion of temperature; expansion with rise of temperature; quantity of heat, conductivity; conservation of energy; the kinetic theory of matter; change of state; radiation and absorption; thermodynamics, radiation.

A better order for the presentation of the subject of heat could hardly be imagined; and as one reads the chapters it is only at rare intervals that one feels called upon to offer any criticisms or to make any comments which are not most favorable. It may not be amiss to mention as being worthy of special praise the treatment of such subjects as the kinetic theory of matter, radiation, the porous plug experiment, the discussion of various phenomena in meteorology, the spheroidal state, and the theory of the radiometer. The most valuable feature of the book is undoubtedly the exact statement of the various theories and their limitations. Thus, in speaking of the radiometer, the authors say: "The theory is altogether beyond our scope, but the following account of what occurs may give some idea of the action. It is to be remembered that it is an account and not an explanation." Various sentences like this may be found throughout the book, and any student must be impressed with the great care taken to give a true account of both experiments and theory. There is one criticism, rather general in its nature, which may be passed upon the whole book, and that is that too much attention is given experiments and observations of former days at the expense of more modern work. It does not seem altogether advisable to discuss so fully experiments which were incomplete or mathematical laws which have been shown to represent the truth imperfectly. This is specially marked in the chapter on radiation. Again, in the description of certain forms of instruments, care is not taken to explain certain essential features in their accurate use, as, for instance, the Bunsen ice calorimeter. It would have been well, further, in discussing the difficulties of calorimetry to say a few words concerning the instrument perfected by Waterman. In the chapters dealing with the specific heat of water and the mechanical equivalent of heat good, bad and indifferent experiments are all described together, and a student is not told which are the best. If so many experiments and observations are to be described, it certainly would be best for a student to be told which are designed with the greatest care and which are the most trustworthy.

These slight criticisms are not meant in any way to reflect upon the excellent character of the book. As a text-book it stands by itself and should be put in the hands of every student of physics early in his course.

J. S. Ames.

Minnesota Plant Diseases. By E. M. Freeman, Ph.D., Assistant Professor of Botany, University of Minnesota. Report of the Survey, Botanical Series, V. St. Paul, Minnesota, July 31, 1905. Pp. xxii + 432. 8vo.

From time to time, it has been the pleasant task of the writer to notice the publication of the Botanical Survey of Minnesota, and to comment upon the thoroughly satisfactory style of publication adopted by the director, Professor Conway Macmillan, of the University of Minnesota. The volume now before us fully maintains the high standard set by the previous publications in this series. In its paper, type, illustrations and binding, this volume leaves nothing to be desired. As one turns over the pages, he is struck by the uniformly high quality of the illustrations, whether they are cuts from line drawings, or half-tones from photographs. They are all

judiciously selected, well printed, and give one the impression of illustrating the text rather than of adorning the book. This is not the case with all recent books, in some of which one suspects that pretty pictures have been used to add to the attractiveness of the pages, with only remote reference to the text.

We are told in the preface that the chief object of this book is 'to disseminate knowledge of the destructive parasites of the useful plants of Minnesota, to assist all concerned in the cultivation of plants, to a more intelligent and thorough understanding of the habits of these parasites, and to point out established methods of combating such diseases.' In carrying out this plan, the author gives about one half of the book to a general discussion of the nutrition, reproduction, life methods, and parasitism of the fungi, their rôle in plant diseases, their kinds systematically considered, the prevention of diseases, fungicides, spraying, etc. This is followed by a special discussion of diseases of timber and shade trees, timber rots, diseases of field and forage crops, garden crops, orchards and vineyards, green house and ornamental plants and wild plants. In connection with each disease, there are brief but clear suggestions as to preventive or remedial treatment. The volume must at once be in great demand in Minnesota, and, without doubt, the small edition of 2,500 copies will soon be exhausted. It is so valuable a book that it is certain to be in demand wherever there are students of plant diseases, and to meet this demand it should be placed on sale.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

Sea-shore Life. The Invertebrates of the New York Coast. By ALFRED G. MAYER. New York Aquarium Series, No. I. Published by the New York Zoological Society. 1905.

Dr. Mayer has succeeded in the difficult task of presenting in a readable and popular form a good deal of information regarding the habits and distribution of the lower marine animals of the coast of New York and of Long Island. A simple description of the appearance and structure of most of the forms is given that will suffice for identification. Especially noteworthy are the large number of new illustrations; most of them photographs of the living animals. While these photographs are not all of equal merit, the majority of them are excellent and valuable.

The book of some 200 pages is not intended as a guide to the New York Aquarium, but it is anticipated that many visitors whose interest has been aroused by the fine exhibit at the aquarium will be glad to learn more about the marine fauna of our coast; and a book of this kind will meet such a need. At present, it is true that the animals in the aquarium are largely fishes and a few other vertebrates, but with the completion of the new salt water system that is now being introduced it will be possible to keep alive many of the more delicate invertebrate forms. When this change occurs the first volume of the New York Nature Series will form a useful compendium to the visitor who desires to study the animals in the aquarium as well as to see them.

Two features of Dr. Mayer's book seem to us to be especially noteworthy. In the introductory statement the theory of evolution is presented in a modest and undogmatic spirit, that will recommend itself to most readers. In the second place many references to more special works are scattered through the text, so that the tyro will be able to follow up any special subject that may excite his interest.

The book is clearly printed and presents a very attractive appearance. It ought to prove useful as well as attractive.

T. H. MORGAN.

SOCIETIES AND ACADEMIES.

THE AMERICAN MATHEMATICAL SOCIETY.

THE one hundred and twenty-fifth regular meeting of the American Mathematical Society was held at Columbia University, on Saturday, October 28. The simultaneous meeting of the American Physical Society afforded an agreeable opportunity for the renewal of cordial relations among the members of the two organizations. The attendance at the morning and afternoon sessions of the Mathematical So-

ciety included thirty members. President W. F. Osgood occupied the chair. The following new members were elected: Professor O. P. Akers, Allegheny College; Dr. R. B. Allen, Clark University; Professor Ernesto Cesàro, University of Naples; Lieutenant Colonel A. J. C. Cunningham, London, Eng.; Miss M. E. Decherd, University of Texas; Mr. W. W. Hart, Shortridge High School, Indianapolis, Ind.; Mr. H. N. Olsen, Bethany College; Mr. F. H. Smith, Southwestern Christian College. Twelve applications for membership in the society were received. The total membership of the society is now 503.

A list of nominations for officers and other members of the council was adopted and ordered placed on the official ballot for the annual election at the December meeting. Dr. W. H. Bussey was appointed assistant secretary of the society.

A committee consisting of Professors Maschke, Pierpont, P. F. Smith, H. S. White, and the secretary were appointed to arrange for the summer meeting and colloquium to be held at Yale University in 1906.

The following papers were read at this meeting:

W. B. Carver: 'On the Cayley-Veronese class of configurations.'

James Pierpont: 'Multiple improper integrals.'

Edward Kasner: 'On the geodesics passing through a given point of a surface.'

H. S. White: 'Poncelet quadrilaterals on a curve of the third order and a conic.'

Max Mason and Professor G. A. Bliss: 'A problem of the calculus of variations in which the integrand function is discontinuous.'

G. A. Miller: 'Groups generated by two operators which transform each other into the same power.'

Burke Smith: 'Determination of associated surfaces.'

L. P. Eisenhart: 'Certain triply orthogonal systems of surfaces.'

The next meeting of the society, which will be the annual meeting for the election of officers, will be held at Columbia University, on Thursday and Friday, December 28–29. The American Physical Society and the Astronomical and Astrophysical Society of America will meet at the same place and time.

The Chicago Section of the Mathematical Society will meet at the University of Chicago, on December 29–30.

F. N. Cole,
Secretary.

THE AMERICAN CHEMICAL SOCIETY. NORTHEASTERN SECTION.

The sixty-second regular meeting of the section was held Friday evening, October 27, in the Walker Building, Massachusetts Institute of Technology, with President Norris in the chair. About 250 members and guests were present. The report of the nominating for officers for 1905–6 was accepted.

Professor Wilhelm Ostwald, of Leipzig, Germany, gave a lecture on the 'Development of Chemistry in France, England, Germany and the United States,' in which he said in part, that chemistry had its earliest development in France, but owing to the centralizing methods of Napoleon I., science had always been monarchical in its tendencies in that country. There had always been a central leader at Paris, who played the rôle of 'king' in chemistry; the succession being Lavoisier, Fourcrois, Berthollet, Gay-Lussac, Dumas, Wurtz and Berthelot, the present ruler, with Moissan already elected the next 'king.' The result had been to greatly retard the advance of the science. Berthelot, for instance, had been able to impose his theories on the whole country, so that it was not until recently in French journals that molecular notation had replaced the older equivalent notation. The doctrine of the conservation of energy was first mentioned in a French journal ten years after its discovery, and the same is true of the theory of electrolytic dissociation. Although lately important discoveries have been made by Becquerel, the Curies, etc., this has been done outside of and in spite of the 'system.' In the same way as the science of chemistry has had one person at its head, it has been centralized in one place, Paris, and very little chemical work has been done in the rest of France.

The opposite conditions have existed in England, where individualism has been the rule. Boyle, Priestley, Cavendish, Davy,

Faraday and others were not connected with the government, and had no encouragement or support from it.

In Germany, which consisted of thirty-six separate different countries during the development of chemistry, there has been a large number of centers of science and independent thinkers. At first Germany was far behind France and England. Liebig was the one who brought about the change. His great discovery of the method of laboratory teaching, of personal teaching supplementing mass teaching in lectures, together with the development of research work as a requisite for graduation at a German university, has led to the enormous development of the science of chemistry in Germany, so that at present over one half or nearer three fourths of the chemical investigation of the world is carried on in Germany, all of which is attributable to Liebig's methods.

In America the development of chemistry has been dependent on the development in foreign countries, and foreign methods have been introduced. At present progress is rapid and the signs are hopeful, but the connection between theoretical and applied chemistry is not so well developed as in Germany, where, at Ludwigshafen for instance, there are one hundred and fifty university graduates employed in technical work in one establishment, and the university professors and scientists in works are in close touch. Professor Ostwald illustrated the close connection of theoretical and practical chemistry in Germany by his own valuable discovery of the preparation of nitric acid from ammonia, by catalytic reactions depending on pure physico-chemical theories.

ARTHUR M. COMEY,
Secretary.

THE CHEMICAL SOCIETY OF WASHINGTON.

THE 161st regular meeting was held Thursday evening, November 9, 1905, in the Assembly Hall of the Cosmos Club. Messrs. S. S. Voorhees and L. S. Munson were elected councilors to represent the Washington Section in the American Chemical Society.

The first paper of the evening, entitled 'Polymorphic Forms of Calcium Metasilicate,' was presented by Dr. E. T. Allen.

The results of the investigation were stated as follows:

Calcium metasilicate ($CaSiO_3$) crystallizes in two different forms, the mineral wollastonite which is monoclinic, and an artificial form which is pseudo-hexagonal. These are enantiotropic polymorphs with an inversion point at 1,190°. The artificial form is more stable above this point, therefore to synthesize the mineral of nature, the melt must first be chilled to a glass, and this then devitrified below the inversion point (800° to 900°). Reversion from pseudo-wollastonite to wollastonite does not take place when the two forms are heated together below the inversion point, but this may be effected by the addition of calcium vanadate which dissolves the pseudo form from the solution of which the more stable wollastonite crystallizes. There is scarcely any volume change in the inversion, the specific gravity of the wollastonite being 2.915 and that of the pseudo-wollastonite 2.912. As an inversion temperature is a point at which two solids are in equilibrium, it remains unchanged no matter what solution the mineral may crystallize from. It is only the temperature of crystallization which is affected.

Since neither pseudo-wollastonite nor paramorphs of wollastonite after pseudo-wollastonite are found in nature, it follows that natural wollastonite has always formed below its inversion temperature; and since wollastonite is very characteristic of contact metamorphic zones, the foregoing may have an important bearing on the temperature of contact metamorphism.

The second paper, entitled 'Investigations on the Properties of Wheat Proteids,' was presented by Dr. Joseph S. Chamberlain.

The conclusions drawn were: (1) The washings from gluten determinations contain 35–40 per cent. of the proteids of wheat, of which about 15 per cent. is composed of the glutinous proteids gliadin and glutenin; (2) the cold alcoholic extract of wheat contains, with the gliadin, about 10–12 per cent. of those pro-

teids soluble in dilute salt solutions; (3) the determination of gluten seems less valuable than that of total proteids (from total nitrogen) and the only separation of proteids that seems warranted for analytical purposes is into (*a*) alcohol soluble, and (*b*) alcohol insoluble.

The last paper of the evening, upon 'The Determination of Mercury and Iodine in Antiseptic Soaps,' was presented by A. Seidell. The method described is briefly as follows: The sample of soap is dissolved in acidulated 95 per cent. alcohol and the mercury precipitated from the clear solution by a stream of hydrogen sulphide gas. After filtration, the iodine is determined in the evaporated filtrate by adding a few drops of nitrous acid, shaking out the liberated iodine with chloroform and titrating the chloroformic solution with standard sodium thiosulphate.

A. SEIDELL,
Secretary.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 605th meeting was held October 21, 1905, with President Littlehales in the chair.

Mr. F. H. Bigelow gave informally some account of the Spanish Eclipse Expedition, the three parties of which had good weather, and of the opportunities enjoyed on the voyage for meteorological observations by means of kites.

Mr. F. E. Fowle then presented 'The Seeliger-Halm theory of double stars' with lantern illustrations.

According to Seeliger a temporary star is the result of the collision of some dark star with a meteoric cloud. The star is rendered incandescent, a rapidly-expanding chromospheric envelope is formed, and it becomes accompanied by a ring of cosmic particles under its own gravitational sway. Halm shows that the expanding atmosphere may be divided into two parts: that directly between the star and the earth causing the dark band displaced towards the violet, and that part at the sides the bright band in its normal position. The superposition of the spectrum of the ring causes the apparent reversals and the changes in the displacements of the bright line. This accounts for the typical Nova spectrum. The evolutionary process of such a system, with simple modifications, accounts for many of the observed spectrum changes.

Mr. L. A. Bauer spoke of the 'Inauguration of the Magnetic Survey of the North Pacific Ocean by the Carnegie Institution of Washington.' In the prefatory remarks the present status of some of the greater problems of the earth's magnetism was set forth and it was shown that their final solution could not be expected until the completion of an accurate magnetic survey of the oceans as well as of the land, and that, however great this task might appear, it could be accomplished with good system and management, and ample funds, within a period of from ten to fifteen years.

The Carnegie Institution of Washington has undertaken to do its part in the removal of this hindrance to progress in terrestrial magnetism by making an initial allotment of $20,000 to inaugurate a magnetic survey in that portion of the oceanic areas—the North Pacific Ocean—where data are especially scarce; practically only results along one line, passing from New Zealand to the Hawaiian Islands and to Yokohoma, from accurate magnetic observations having been secured thirty years ago by the *Challenger* expedition. The cooperation of existing magnetic institutions is likewise assured through the action of the International Committee on Terrestrial Magnetism and Atmospheric Electricity, which met at Innsbruck, Austria, last September.

A brief summary was given of previous expeditions and then with the aid of lantern slides views were shown of the Carnegie Institution vessel, the fast-sailing wooden *Galilee*, and of the instruments, accompanied by a description of them and of methods in use. The four instruments enable the three magnetic quantities to be observed in duplicate.

In conclusion it was shown that whenever conditions of weather and sea permitted the making of the magnetic observations on equidistant headings of the vessel for a complete 'swing' forward and back, the average results obtained possessed a very high order of ac-

curacy, and that if it were necessary to still further increase the accuracy of the results, this could be done by spending additional time in the observations. When observations can not be secured on a complete 'swing,' but simply on the regular course of the ship, it is not always possible to mathematically control the deviation corrections applied, owing to accidental conditions entering in. While these corrections in the case of the vessel employed are comparatively small as compared with those of other expeditions, they are of sufficient amount to require being taken into account in securing data of the precision requisite for the solution of some of the greater problems referred to above. Considerable time would be saved were it possible to have a vessel entirely non-magnetic so that the question as to corrections to be applied on account of magnetism of any portions of the ship need not be considered.

The results thus far secured by the *Galilee* on her cruises from San Francisco to San Diego and from there to the Hawaiian Islands, as well as some results obtained by the Coast Survey vessel in the Pacific Ocean—the *Patterson*—proved that the latest magnetic charts are systematically in error, as far as the magnetic declination is concerned, to the extent of from one to two degrees, the charts giving too low values of easterly declination. The lines of equal dip appear to be correct on the average within about one third of a degree. The lines of equal horizontal intensity are systematically erroneous to the extent of one twentieth to one thirtieth part of the absolute value—fully ten times the error of the observation—the charts giving too high values. A consideration of the values obtained by the Coast Survey vessels in the Atlantic Ocean, especially between Baltimore and Porto Rico, likewise shows that the intensity charts give values too great by about the same ratio as in the case of that portion of the North Pacific Ocean considered above.

The president followed with some extended remarks on the subject.

THE 606th meeting was held November 4, 1905.

Mr. H. B. Brooks described, by invitation, 'An Efficiency Meter for Incandescent Lamps' developed by Mr. Hyde and himself for use at the Bureau of Standards. The purpose of this is to give a direct reading of the quotient of the watts used by the candle-power; for commercial 16 c. p. lamps this quotient is three to four. A Weston wattmeter is used, but enough extra resistance is added in the shunt circuit (which has normally some 2,000 ohms resistance) to bring the deflection of the needle down to ten times the quotient, as from 64 to 40. Since this resistance must vary with the observed candle-power, part of it is wound on a block of carefully calculated form and a contact piece carried along with the photometer screen cuts out resistance as the candle-power increases. The instrument is reliable to about one per cent.

Mr. W. P. White then presented 'A Thermal Study of the Mineral Wollastonite' made by himself and Messrs. Allen and Wright. This substance, often found in lavas, was studied to get a probable limit to the temperature that the lava had reached.

Calcium metasilicate, $CaSiO_3$, exists in two forms; one, wollastonite, stable below about 1,180°, and a monoclinic form stable above that temperature. If wollastonite is heated, it changes readily to the other form, but to get the reverse change is often a matter of some difficulty. Hence, on cooling a charge of the melted material, if crystallization occurs, as it usually does, above 1,180°, pseudo-wollastonite is found. It is only now and then that the undercooling is great enough to allow wollastonite to crystallize. Wollastonite can be formed readily, however, by chilling melted material so that it becomes glassy at ordinary temperatures, and then heating this glass to a dull red heat. The melting point of the pseudo-wollastonite is 1,512°. Nine determinations on four separate samples showed a maximum variation of 2½° in the determination of this point.

In locating the inversion temperature in the electric furnace, great help was obtained by the use of control elements which gave simply the furnace temperature and enabled

allowance to be made for its fluctuation. It is well known that thermoelements deteriorate at high temperatures. This results in an incorrect reading and the error depends on the distribution of temperature in the furnace and, therefore, on the amount and nature of the charge which is being examined, etc. Trouble from this source was largely removed by comparing the working elements with standards which were used for so short a time as to hold their values practically unchanged for several months. The comparison must be made under exactly the conditions for which the temperature reading is intended. Thus for best results in the determination of melting points, comparison must be made during the melting. The relative error of a temperature measurement below 1,550° can in this way be brought within half a degree.

One conclusion from the work is that the temperature of lavas where wollastonite is found can not have exceeded 1,163°.

CHARLES K. WEAD,
Secretary.

DISCUSSION AND CORRESPONDENCE.

DR. O. F COOK'S 'SOCIAL ORGANIZATION AND BREEDING HABITS OF THE COTTON-PROTECTING KELEP OF GUATEMALA.'

SOME of the results of the continued work of the United States Department of Agriculture on the ponerine ant, *Ectatomma tuberculatum* Olivier, introduced into Texas for the purpose of aiding in the extermination of the cotton boll weevil, are given in this paper of fifty-five pages in advance of an illustrated bulletin or report on the same subject. Dr. Cook's paper can hardly be passed over without comment, since it displays so many misstatements of fact, such inadequate knowledge of the work that has been done on other species of ants, and such a wilderness of unkempt argument and speculation as to entitle it to high rank as an example of what a scientific essay should not be.

The burden or 'Leitmotiv' of the whole paper is properly sounded in the introduction, which is well worth quoting in its entirety:

In preceding reports treating of the kelep as an enemy of the cotton boll weevil the distinctness of its behavior from that of the true ants has been noted. To avoid in some measure the misapprehension likely to be caused by calling it an ant it seemed desirable to introduce with the insect its distinctive Indian name, *kelep*. In the minds of the natives of Guatemala, the kelep is not a kind of ant, but an independent animal not to be associated with ants. The more we learn about it the more this aboriginal opinion appears justified, not alone because the kelep is a beneficial insect, but because it has a different mode of existence and a different place in the economy of nature.

The popular classification of the social hymenoptera recognizes three types—the ants, the bees and the wasps, the ants being distinguished from the others by the absence of wings. The kelep falls, however, into none of these groups. To call it a wasp or a bee would not misrepresent the practical facts more than to call it an ant. In reality the kelep represents a fourth category of social hymenoptera, as distinct from the other three as they are from each other. Authorities on the classification of the hymenoptera have admitted a rather close affinity between the wasps and the ants, but the kelep differs from both of these groups and approaches the bees in important respects, and especially in those which affect the question of its domestication and utilization in agriculture.

It was naturally supposed at first that the kelep would have the same habits as the true ants which have been associated with it as members of the same family or subfamily, but the differences were greatly underestimated. If the hymenoptera were classified by a taxonomic system consistent with that applied to the higher animals, the kelep would need to be recognized as the type of a new and distinct family. It is, moreover, the first member of its family of which the habits have become known. Under such circumstances it was quite impossible, obviously, to determine in advance whether its habits and instincts would permit its colonization in the United States and its use in agriculture.

The fundamental difference between the ants and the kelep, and that in which the latter resembles the honey bee, lies in the methods of swarming. Among the bees and the keleps swarming results directly in the formation of new colonies, but the swarming of the ants is a distinct biological phenomenon having for its object cross-fertilization. The kelep is completely socialized, like the honey bee, while the ant is not. The keleps and the honey bees live only in communities, while the ants at one stage of their life

history leave the nest and meet the vicissitudes of independent existence as solitary individuals, like the non-social insects. The social organization of the kelep represents a line of development distinct from that of the ants, and shows a relationship with the parasitic and predaceous wasps rather than with the true ants.

Although fresh surprises meet the reader at every turn as he proceeds to read the paper through, he is led to suspect that Dr. Cook, in spite of his fluent style, may at times be unable to say exactly what he means. He evidently wishes to make us believe that the kelep *quâ* dried insect, spitted on a pin, is nothing but a poor ponerine ant, but *quâ* living, nest-building, boll weevil exterminator, is really a creature *sui generis* which the advanced systematist would do well to regard as the sole representative of a distinct family, the Kelepidæ. Here Dr. Cook shows admirable self-restraint, for it might just as well be made the type of a new phylum (Kelepata) or subkingdom (Kelepozoa). At any rate, it is clear that the kelep rises to a dignity analogous to man, whom certain theological taxonomists regard as a poor, though upright primate physically, but as belonging psychically to an entirely different order of being, because he is possessed of the 'free intelligence of the angels.'

Dr. Cook's amazing estimate is attributable to a confusion of ideas concerning certain well-known phenomena among social insects in general and to a lot of inconclusive, not to say slovenly, observations on the kelep in particular. He begins by confounding the nuptial, or marriage, flight and the swarm, or, at any rate, by continually introducing these in his discussion where they do not belong. The nuptial flight is a well-known occurrence in all social insects that have winged males and winged females, in the honey-bees as well as in the ants and termites. Nevertheless, Dr. Cook believes that it is sorely in need of a new name and suggests 'concourse,' a designation as superfluous as it is inept. Swarming, on the other hand, which is peculiar to the honey-bee, is characterized by the old queen leaving the hive with a detachment of workers and establishing a new colony, while the young queen takes her place with the remaining workers. When he comes to consider the possible occurrence of this phenomenon in the kelep, Dr. Cook increases the confusion by failing to distinguish sharply between 'nest' and 'colony.' A single colony of ants may be confined to a single nest, in which case it has been called monodomous by Forel, or it may extend over several nests, in which case it is polydomous. The latter may have several queens distributed among the different nests. The workers of these are on friendly terms with one another and may visit back and forth. Undoubtedly the inhabitants of such nests occasionally become detached from the parent colony and may be regarded as new colonies formed by a process of budding or stolonization. These conditions are well known, in such highly endowed ants as our species of *Formica* and *Camponotus* (*F. rufa, sanguinea, exsectoides, C. maculatus* var. *sansabeanus*, etc.). While there is an unmistakable resemblance between this method of colony formation and the swarming of bees, these ants retain in addition the primitive method of founding colonies by single deälated queens.

Now Dr. Cook's confusion of ideas and lack of information are most flagrantly displayed when he comes to present the facts that seem to him to warrant the separation of the kelep from the true ants and ally it with the honey-bees. Having made the interesting observation that a kelep colony will form new nests by sending out detachments of workers and females or of workers alone, he shuts his eyes to the resemblance between these conditions and those of the higher ants, and forthwith jumps to the conclusion that the kelep can not be a true ant, but must be at least as closely related to the honey-bee.[1] Obviously the very opposite is true, since his observations, rightly interpreted, show a closer relationship between the kelep and the higher ants than has been supposed to exist among

[1] "Kelep nests are frequently placed only a few inches apart, the workers of different colonies not being actively hostile. Members of two colonies will forage on the same cotton plant or tree trunk with no signs of animosity" (p. 14).

the Ponerinæ. But this is not all. Because he has never seen a nuptial flight of male and female keleps, he jumps to the further conclusion that it never occurs and that colonies of this ant can not be founded by solitary females. He says at p. 34, 'there is no provision in nature for a solitary kelep.' His whole description of the nesting habits of the kelep discloses nothing to warrant such a gratuitous assumption. As the colonies are small, their nuptial flights would hardly be noticed by the Indians of Guatemala and may, moreover, occur only during certain years or in the twilight or after dark. That they have not been seen in the colonies brought to Texas is even less surprising, as such flights among other species are celebrated only by flourishing colonies, and everything goes to show that Dr. Cook's importations are not in that condition. The large number of males which he finds suggests a high degree of fertility on the part of the workers. It does not, however, indicate colonial prosperity in these ants, but a scarcity of females. Very similar conditions have been observed by Miss Holliday[2] and myself in another ponerine ant, *Pachycondyla harpax* of Texas, which does not form polydomous colonies.

It is, of course, possible that the nuptial flight may not occur in the kelep, that the males may wander about and fertilize the females within the nests, and that new colonies may be formed exclusively by a process of budding or subdivision of preexisting colonies. But if this is true, we should be led to inferences very different from those announced by Dr. Cook. Far from having 'complete socialization' and representing a higher and more economical form of social life, the kelep would seem to be a retrograde, degenerate or, at any rate, highly specialized ant for the reason that just such conditions, at least so far as the suppression of the nuptial flight and intranidal mating are concerned, occur, in all probability, among the parasitic ants like *Anergates, Symmyrmica, Formicoxenus,* etc., and in highly specialized ants like the Dorylinæ and *Leptogenys*, which are either rare or have an unusual mode of life. And far from being a promising trait in an ant introduced for economic purposes, the very opposite would be the case, as seems to be indicated by the flat failure of Dr. Cook's propaganda. It may be best, however, to refrain from all speculation on this matter till we know more about the colonizing habits of the kelep than can be learned from Dr. Cook's desultory statements. There can be no doubt about the fact that isolated fertile females of certain Ponerinæ are able to establish colonies. In the Bahamas I found satisfactory evidence of this both in *Pseudoponera stigma* and in *Odontomachus insularis,* and Dr. Cook is still a long way from having proved that the same method is never adopted by *Ectatomma*.

[2] 'A Study of Some Ergatogynic Ants,' *Zool. Jahrb. Abth. f. Syst.*, XIX., 4, 1903, p. 297, 298.

Additional confusion is introduced by Dr. Cook with a set of new terms. He calls 'an insect colony in which all the eggs are furnished by a single laying queen' a 'strictly determinate organization, that is, it reaches a natural limit after the mother insect dies or ceases to reproduce,' and 'colonies may be called indeterminate when the social economy of the insect is such that a lost queen can be replaced.' "Colonies with more than one egg-producing queen may be called compound indeterminate." All of these distinctions are at the present time not only superfluous, but misleading. According to prevailing theory, all ant, wasp and honey-bee colonies would be determinate, since it is supposed that they can not produce females after the reproductive exhaustion or death of the queen. And, for aught we know to the contrary, the same may be true of the termites. Until we are sure that this is not the case, we gain nothing but confusion by adopting such a classification.

Equally futile is his distinction between the 'social principle of matriarchy' and 'ergatarchy' among the social insects. As a member of a colony, the female ant, wasp or humble-bee is no more a ruler or dominating factor in social life than the queen honey-bee. If the female ant, wasp and humble-bee display great initiative in founding their respective colonies, the female honey-bee displays it by killing rival queens, returning to the hive after the nuptial flight, etc.

The following remarks quoted at random from Dr. Cook's paper show the care with which he has studied the literature of his subject. At p. 9 (foot-note) he says:

With these fungus-cultivating ants and termites, at least, it would seem that a new colony can scarcely be founded by a pair of sexual termites or by a single fecundated female ant unless they carry their domesticated fungus with them. It is possible, however, that in both cases the newly mated insects are adopted and set up in housekeeping and farming by workers of their own species, who bring 'spawn' of the fungi from the older colony with which they are in communication. This might the more readily happen because long subterranean galleries are a prominent feature of the architecture of the fungus-growing insects, both ants and termites.

Although nothing is known concerning the origin of the fungus gardens among termites, von Ihering, in an article[3] which should be known to every botanist, has shown that the colonies of *Atta sexdens* are established by isolated queens and how these insects carry over the fungus from the maternal nest to their own. These observations have been fully confirmed by Goeldi[4] and Huber.[5] At p. 24, Dr. Cook says: 'Copulation has never been observed among termites.' On the contrary, it has been repeatedly observed by at least one observer, Dr. Harold Heath.[6] At p. 19 we find the statement that in '*Leptogenys*, the females, though wingless, are very different from the workers.' Miss Holliday and myself have shown in three different papers that the females of this ant can be distinguished from the workers only by a difference in the size of the abdomen and the enclosed ovaries. At p. 17 we find the following statement:

It does not appear that the keleps have the art of regurgitating food for their larvæ or for each other, but they have, instead, the curious habit of opening their mandibles wide and lapping up drops of nectar, moistened sugar or honey on their mouth-parts. The liquid is thus carried into the nest and dispensed to the other members of the community, old and young. The queen is regularly fed in this way, though in a few instances, the queens of captive colonies came to the surface to eat sugar with the workers.

The mode of expression is varied to read as follows at p. 42:

The kelep does not appear to have the art of regurgitating food as do the true ants, but it is the regular custom of the workers to gather up on their mouth parts large drops of nectar, syrup or honey, which are carried into the nest and freely dispensed to the remaining members of the community, as well as to the queen and larvæ.

To any one familiar with the structure of the mouth-parts of the kelep and with the behavior of ants while they are feeding one another, these statements can only mean that the kelep, like the higher ants, not only ingurgitates liquid food, but feeds the other members of the colony by regurgitation. Here, again, Dr. Cook makes a botch of an interesting observation in his desire to make the kelep out to be a most exceptional creature.

In another part of the paper he shows that this ant also feeds its young with pieces of insect food in exactly the same manner as I have described for other Ponerinæ and some of the higher ants (*Aphænogaster, Pheidole*), and as Janet has shown for *Lasius* and Adlerz for *Tomognathus*. Instead of drawing the natural conclusion that the kelep is allied to both the Ponerinæ and higher ants, Dr. Cook concludes that its relationships are 'with the parasitic wasps rather than with the ants.' It is evident that he will be satisfied with any relationship except the true one. As a matter of fact, every habit which he describes shows that the kelep is nothing more nor less than a ponerine ant. It differs from the Ponerinæ hitherto studied and approaches the higher

[3] 'Die Anlage neuer Colonien und Pilzgärten bei Atta sexdens,' *Zool. Anzeig.*, Bd. 21, 1898, pp. 238–245, 1 fig.

[4] Forel, 'Einige Biologische Beobachtungen des Herrn, Prof. Dr. Goeldi an brazilianischen Ameisen,' *Biolog. Centralbl.*, XXV., 1905, pp. 170–181.

[5] 'Ueber die Koloniengründung bei Atta sexdens,' *Biolog. Centralbl.*, XXV., 1905, pp. 606–619, 625–635, 26 figs.

[6] 'The Habits of California Termites,' *Biol. Bull.*, IV., 2, December, 1902, p. 52.

[7] *Loco citato*, pp. 295–297. 'A Study of some Texan Ponerinæ,' *Biol. Bull.*, II., October, 1900, p. 7; and 'A Crustacean-eating Ant (*Leptogenys elongata* Buckley),' *Biol. Bull.*, VI., 1904, p. 251.

ants in having the power of feeding by regurgitation and of forming polydomous colonies. These conditions merely serve to link the Ponerinæ more closely with the Myrmicinæ, Camponotinæ and Dolichoderinæ. Dr. Cook destroys the value of his own observations by continually using them in support of his perverse speculations. I can see no reason, therefore, for revising my opinion in regard to the taxonomic and economic status of the kelep as expressed in two previous papers in this periodical.[8] Apparently the harder Dr. Cook works to confer exceptional attributes on the kelep, the greater becomes its similarity to other ants, especially to the relatively unplastic Ponerinæ, and hence the less promising it becomes as a subject for agricultural experiment.

The sole result, which, in my opinion, we had a right to look forward to, from all this Corybantic enthusiasm over the introduction of an exotic ant into the United States, was not the protection of the cotton plant from the attacks of the boll weevil, but the production by some well-trained entomologist of a carefully written and illustrated memoir on the structure and habits of a ponerine ant. Under the circumstances and with the funds and facilities at its disposal, this lay well within the competence of the Bureau of Entomology, and may, in fact, be actually under way in the promised report. But assuredly Dr. Howard is not to be congratulated on the kelep articles hitherto published under the auspices of his bureau. We are accustomed to receiving much better work from that quarter.

William Morton Wheeler.

[8] Science, September 30 and December 2, 1904.

ISOLATION AND THE ORIGIN OF SPECIES.

President Jordan's paper 'The Origin of Species through Isolation'[1] has been read by me with much interest. The following paragraph may be quoted as the caption under which he writes:

> In nature a closely related distinct species is not often found quite side by side with the old. It is simply next to it, geographically or geologically speaking, and the degree of distinction almost always bears a relation to the importance or the permanence of the barrier separating the supposed new stock from the parent stock.

It appears to me, however, that the case as stated by him can find scant support of the botanists, to whom it is, I think, easier to find exceptions to the rule, than facts in support of it. The question is, of course, a very complicated one and all who embark on a discussion would fain sound the '*obligato*' of Leonard Stejneger, 'so far as I know.' A few instances drawn at random will suffice at least to throw a reasonable but large doubt upon the factor of isolation and the extent of its effects, as stated by President Jordan, at least so far as plants are concerned, and this doubt should, I believe, obligate us to put the caption cited above into the form of an open question.

Lycopodium complanatum L. and *L. tristachyum* Pursh are two very distinct but closely related species of club-mosses occupying the same range. If we attempt to construct a theory of their origin we are compelled to regard them as genetically related, whatever the mode of origin may have been. These species often grow intermingled in the same habitat, and it was the contrast which they presented under such conditions which forced me to examine them with great care and finally to decide upon their distinction.[2] And if, as has been urged, our eastern North American plant, *L. complanatum*, is not the true European species, the case is strengthened rather than weakened.

In the deserts of the southwest are to be found numerous closely related species of cacti, especially of the genus *Opuntia*, occupying the same habitats and, perhaps, the same ranges. It would be difficult to apply the principle of isolation to these. As an example I may say that there are two distinct but closely related species of the prickly pear type, which I may not, in the present state of their taxonomy, presume to name, distinguishable by their fruits, which are in one species

[1] Science, II., 22: 545–562, November 3, 1905.

[2] Lloyd, F. E., 'Two Hitherto Confused Species of *Lycopodium*.' *Bull. Torrey Botan. Club*, **26**: 559–567, November 15, 1899.

globose and dark red, and in the other obconical and yellow and brown, in maturing, respectively. The hybrid character of some individuals must be admitted in theory, b· the presence of the two types associated in the same habitat is beyond doubt.

Again, to cite a striking, if sweeping, illustration, it is to be properly appreciated that all the species of the fleshy Euphorbiaceæ are confined to one grand region, and all the analogous species of the Cactaceæ to another. The species composing a genus may not be exactly coextensive, but the ranges of many species may and often do overlap, and are to this extent coincident.

Among the violets, the old species, of Gray's 'Manual,' *Viola palmata,* a few years ago was made to comprehend a number of 'varieties' then so called. These have now been shown to be a number of distinct but closely related species, some of which, at any rate, exist side by side in the same habitats and have the same or similar ranges. The same may be said of the certain yellow, stemmed violets, and of the white violets, *V. lanceolata* and *primulæfolia.*

Two species of *Drosera, rotundifolia* and *longifolia,* are constantly found together and are usually expected to be so found by every collector. Two other species are often associated with them, though not always.

Œnothera biennis and *O. Oakesiana* grow together in the same habitat. So also *Asclepias incarnata* and *pulchra,* two species of the milkweed which are not readily recognized by the tyro, but are yet perfectly distinct, grow constantly associated in the same swamp.

Rhodiola integrifolia is distributed from Colorado to Alaska. In Colorado *R. polygama,* closely related to it, is found with it in the same habitat. The two are not separated by any geographical barrier.

Of the *Potentilla* quite a number of species are very often associated, especially those of the *nivea, gracilis* and *rubicaulis* groups. Three or four of the species may usually be found growing in the same patch of an area not larger than a good-sized room. Of the sedges, many species, often closely related, are to be found in the same bog.

The hammocks of Florida are particularly interesting in this connection because of the great number of species to be found in restricted habitats. Two species of white-flowered *Lantana, odorata* and *involucrata,* are always or nearly always found together, and this applies to the two yellow-flowered kinds, *depressa* and *ovatifolia.* The two live-oaks, *Quercus geminata* and *Virginiana,* are in the same case. *Catopsis nutans* and *Berteroniana* grow intermingled on the same tree, and the same may be said of many other epiphytic species, including Tillandsias, Epidendrons and other orchids. It is worthy of remark that just at the places where the struggle for existence may be presumed to be the most intense between the individuals of the vegetation there also do we find many examples of the same association of closely related species.

Among the ferns, examples are numerous, notably so again in the case of the tropical epiphytic filmy fern, Elaphoglossums and Polypodiums, which grow intermingled, as every one can testify who has examined herbarium specimens which are often composed of two closely related species and therefore not discerned as such by the collector. In Jamaica there are a half-dozen species of tree-ferns which are endemic to the island and are practically always intermingled! Of northern edaphic species *Botrichium obliquum* and *dissectum* are always expected to be found growing together, and the same may be said also of *B. neglectum* and *lanceolatum. Dryopteris Goldieanum,* though more restricted in its choice of habitat than *D. marginale,* is often found with it.

Examples among the mosses and liverworts are abundant. *Orthotrichum Brownii, Ohioense* and *brachytrichum* may not infrequently be found mixed together, and even three other species of this genus may be associated with them, all growing on trees. The rocks support, for example, *Dicranum longifolium* and *viridis,* often components of the same tuft, and thus also *D. fuscescens* and *montanum.* Concerning the liverworts, a citation from Spruce is instructive: "I have a small tuft

gathered by Mr. Stabler on Bowfell which comprises five species of *Marsupella* intermingled in the space of a square inch." Be it remembered that Spruce was a most critical student of these forms.

And, if these are proper examples, what of the numerous species of oaks, willows, thorns, asters, golden-rods and many others which spring up in hosts to challenge our scrutiny? Certainly we should think long before applying the principle advocated by President Jordan to these. And what too, shall we say of the many species of the Siphoneæ, the sea-fans, shaving-brushes and their like which grow in the warmer waters of the tropics, many closely related kinds in restricted and identical localities, a condition quite analogous, I venture to say, to the distribution of the oaks, willows, *et cetera*.

It therefore appears that the general law as stated by President Jordan, 'Given any species in any region, the nearest related species is not likely to be found in the same region nor in a remote region, but in a neighboring district separated from the first by a barrier of some sort,' would be more in harmony with the facts in the case as understood by the botanists if stated in the converse form.

President Jordan further admits that, theoretically, mutations may arise which may hold their own in competition with the parent form, but states that such a condition is virtually unknown.[4] This, however, is far from being the case among the plants. Aside from the many properly designated species in cultivation, we have definite, well-authenticated cases of uncultivated forms which give denial.

In 1886, de Vries found in the fields of Hilversum a plant, *Œnothera brevistylis*, which turned out to be a mutant of *O. Lamarckiana*. Although *O. brevistylis* produces comparatively few seeds compared with the parent form, and has not arisen anew as a mutant since the time of its discovery, it has, nevertheless, been able to maintain itself alongside the parent species in the original habitat up till the present time. *O. brevistylis* may be artificially crossed with the parent form and when this is done the progeny split according to the Mendelian principle, so that, even if this were the means of propagation upon which *O. brevistylis* depends, the race would be maintained.

[3] *Rev. Bryologique*, **8**: 104. 1881.

[4] *L. c.*, p. 545.

Without recounting the case of *Capsella Heegeri*, and other well-known instances which are completely authenticated, we may see that it is unwise for us to ignore the probability that the same thing has occurred in nature very many times.

The examples which I have given above are only a few of a thousand which might just as easily be recited and have occurred out of hand to me and to a few of my colleagues whom I have questioned on the matter.

Apropos of the proposition[5] that all the organisms in a region unbroken by barriers will slowly change together in the process of adaptation by nature, I may be permitted to point out that it is again still an open question whether this is the method by which a peculiar flora has attained its apparent uniformity. Curiously enough we find markedly desert types, *e. g.*, *Zyzyphus*, a thorny shrub of the desert, growing chiefly along water courses, and opposite types, as *Verbena ciliata*, which can not be seen to differ from a so-called 'mesophytic' garden weed, ecologically or physiologically, getting along quite well in the habitat of *Cereus giganteus*, the ocotillo (*Fouquieria splendens*) and a lot more specialized enough plants. Similarly we find, for examples, a species of *Opuntia*, *O. Opuntia*, growing in our eastern states associated together with mesophytes, just as we find many mesophytes growing in arid deserts. Why? The answer to this query involves some answer to the problem of the origin of desert floras, one, however, which has not yet been solved.

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THE SMALL MOUNDS OF THE UNITED STATES.

IN the two papers on the probable origin of the small mounds in the southern and western parts of the United States, which have ap-

[5] *L. c.*, p. 547.

peared in SCIENCE during the present year,[1] the writers have quoted and advanced many and varied theories, none of which, however, appear to be entirely acceptable even by themselves. But why should all these small elevations which evidently occur in large numbers, scattered over widely separated areas between the Mississippi and the Pacific, be considered as having been caused by the same agency? It is impossible to imagine any one natural cause which could have resulted in the formation of all. One theory attributed their origin to glacial action, another considers them to be the work of ants.

Some of the mounds—those in the far northwestern part of the country—may be of glacial origin; if so it should not be a difficult question for a competent geologist to determine. But the same theory can not, of course, be applied to those in the lower Mississippi Valley, for the obvious reason that the glaciers did not extend that far south. Likewise the 'ant hill' theory, when the mounds are considered as a whole, is as equally inapplicable, not only on account of their wide distribution and occurrence far north, but also by reason of the various soil formations of which they are composed. Were they the work of ants some traces or indications of the cavities and passages would certainly be discernible, but such is not the case. The mounds which I have examined in Missouri show no such indications, and Mr. Branner, referring to those on the Pacific coast, writes:

> In California hundreds of mounds have been cut through by railways and by common roads, and many such sections have been examined. The cuttings, being made without any special care exhibit only a compact clayey hard-pan that shows no signs of burrows or anything that has been recognized thus far as different from the soil of the adjacent areas.[2]

Other theories, such as the 'spring and gas vent' and the 'dune,' are without foundation and are scarcely worthy of being mentioned.

Both papers to which I have referred mention the mounds as existing as far north as the Arkansas, but do not allude to the numerous groups which occur in Missouri. These are of a similar form and size and the description of one group appears to be applicable to all.

About four years ago I had occasion to excavate many small mounds that stood on the site of the World's Fair in St. Louis. They formed two groups, one on the ridge, the other not more than six hundred yards distant, was in the lowland on the bank of the small River des Peres. All the mounds of both groups were of a uniform size and were considered as being the same in every respect. But when excavated those on the ridge were found to be ruined habitations. The original surface which served as the floor was readily distinguished. Near the center was the fire bed with ashes and charred wood, worked flint and many small fragments of cloth. Marked pottery were also found on the same level. The mounds of the lower group were likewise examined, but, unlike the others, nothing was found to indicate their origin or use. It will thus be seen that the same theory of origin will not apply to mounds of the same size and appearance when only a third of a mile apart. How unreasonable it is, therefore, to attempt to apply the same theory to those several thousand miles from one another.

I have already mentioned the large groups that exist in Missouri.[3] In Dallas County, in the southern part of the state, they are particularly numerous; many extend in parallel rows along the water courses in the lowlands and others, hundreds, occur in rows on the western slopes, while comparatively few are found on the eastern. Many of these mounds were examined, but nothing was discovered to shed light on their origin; they resembled the lower of the two groups on the fair site, to which I have already referred.

Near the center of one large group of these mounds was one which, although of the same

[1] February 24, 1905, p. 310. A. C. Veatch: 'The Question of Origin of the Natural Mounds of Louisiana, Arkansas and Texas.' Also March 31, 1905, p. 514, 'Natural Mounds or Hog-wallows,' J. C. Branner.

[2] SCIENCE, March 31, 1905, p. 515.

[3] *American Anthropologist*, 1904, p. 294.

size and form, was composed of pieces of limestone, all of which had been carried there. The vegetable mold, the accumulation of a long period of time, had so filled the intervening spaces that the true character of the mound was only revealed when an excavation was made. This mound was between three and four feet in height and about forty feet in diameter. Here we have unquestionable evidence of the work of man. Several other mounds, less than one hundred yards distant, were composed solely of earth and mold similar to the surrounding area.

Probably if these small mounds were not so numerous the question of their origin would never have been raised and they would have been considered, together with the larger mounds, as having been made by man, but the question of number should not influence the decision. It is doubtful if the combined bulk of all these small mounds in the Mississippi Valley is more than equal to that of the one great mound of the Cahokia group.

Without conclusive proof to the contrary, I feel that the most plausible theory of the origin of these small mounds, in Missouri and in other localities where they occur under similar conditions, is that they were made by man, probably to serve as elevated sites for habitations. D. I. Bushnell, Jr.

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SPECIAL ARTICLES.

THE LOCH LEVEN TROUT IN CALIFORNIA.

In the year 1896 the State Fish Commission of California sent to Captain H. C. Benson, acting superintendent of the Yosemite National Park, five hundred young trout of the species known as Loch Leven trout, *Salmo levinensis*, to be planted in waters of the park. These were placed in a branch of Alder Creek, near Wawona, where they have been allowed to remain undisturbed until the present year.

This Loch Leven trout has been usually considered as a valid species, distinct from the other trout of Great Britain, distinguished from the common brook trout, *Salmo fario*, by the large size, more silvery color, sparsity of spots, the red spots and ocelli characteristic of the brook trout, or brown trout, the trout of Izaak Walton, being usually wanting. The orange edge of the adipose fin, characteristic of the brook trout, is wanting in the Loch Leven trout. The mouth in the latter is said to be smaller, and other differences have been pointed out, but the validity of these structural distinctions has been stoutly denied by Surgeon Francis Day, who has made careful studies of the trout of England.

This fall, Captain Benson caught some fifty-four fishes from the branch of Alder Creek, derived from this plant of Loch Leven trout. These varied from two to seven inches in length, but to his surprise and dismay, he found them corresponding exactly to the markings of the English brook trout, called *Salmo fario*, as shown in the figure published by Mr. W. C. Harris. Four fishes, caught by hand in the brook, he sent to me. They are in fact, so far as one can see, exact representatives in form and color of the common brook trout as seen in the streams of England. The adipose fin is edged with orange. The sides are covered with spots of brown mixed with spots of scarlet, more or less ocellated. These Loch Leven trout in the Yosemite are typical *Salmo fario*, or brown trout of England. Dr. Day speaks of the Loch Leven trout as changing into ordinary brook trout, when planted in streams of Gloucester or Guildford, the colors of the Loch Leven trout being seen on exceptionally well-fed individuals only. In Australia, according to Day, fine examples of the Great Lake trout, *Salmo ferox*, weighing twenty pounds have been reared from eggs of *Salmo fario*, taken in Hampshire and Buckingham. Day also notes that 'a Loch Leven trout having been crossed at Howietoun by a salmon-parr, the offspring possessed the orange-tipped adipose dorsal fin which is seen in the young of the sea trout and the brook trout, and it may be asked from whence had such been obtained unless the Loch Leven possessed the blood of one of these races?' The case is exactly parallel with that of the common trout of Japan, *Salmo masou* Brevoort, which is mature at all sizes from three

ounces to fifteen pounds, and which loses its colors and spots when it enters the sea or when it reaches a large size. Similar changes are shown in each of the four coastwise species of trout of the Pacific coast.

The explanation is apparently this. The trout in Loch Leven is identical as to species with the ordinary brook trout of England. The character of the food supply and of the water of the lake determine its color and appearance. These acquired characters are not hereditary, but are results of conditions in the growth of the individual. The lake trout planted in the brooks grow as other brook trout do. In estuaries of rivers they assume still other characters, and these are equally temporary.

I have no doubt that Dr. Day is right in regarding the large salmon trout of the English bays (*Salmo trutta* L., *Salmo eriox* L., *Salmo cambricus, Salmo albus, Salmo phinoc, Salmo brachypoma*), the golden trout of the estuaries (*Salmo estuarius, Salmo orcadensis, Salmo gallivensis*, etc.), the silvery trout of the various lakes (*Salmo levinensis, Salmo cæcifer*), the great black lake trout (*Salmo ferox, Salmo nigripinnis*), the 'gillaroo,' with the stomach coats thickened (*Salmo stomachicus*), and the common trout of the brooks of northern Europe (*Salmo fario* L., *Salmo ausonii, Salmo gaimardi, Salmo cornubiensis*) as all forms of one and the same species. A member of one of these so-called species would be changed to one of the others if it grew up under the same surroundings. These forms are not subspecies, for that implies a divergence which should be hereditary, however slight. They are, if this view is correct, local variations of one species, for which the oldest name is the half-forgotten one of *Salmo eriox* Linnæus.

A practical question with fish-culturists arises here. "The riparian proprietor," says Dr. Day, "sends for, let us say, *Salmo ferox*, to improve the strain of his local race by crossing, and after a year or two he feels confident that the imported forms are only brook trout. Naturally indignant, he may come to the erroneous conclusion that the purveyor has imposed on him and it will not be until he understands this is a simple variety attaining a large size, due to certain local circumstances, that he will comprehend how his money has been thrown away. He had far better look to the food and condition of the water on his estate before attempting to improve the indigenous breed." DAVID STARR JORDAN.

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THE RELATION OF SOIL TEXTURE TO APPLE PRODUCTION.

THE problem of the intelligent selection of an orchard site by a person who contemplates engaging in the production of apples on a commercial scale, or even in a small way, resolves itself into several factors. The climate must be suitable and the physiographic features, including exposure and the attending surface conditions, aeration and drainage, must be favorable. The relation borne to variety by climate, and to a lesser degree by physiographic position, must be carefully determined, for whereas a considerable part of the United States is suited to apple production, certain important varieties, as the Albemarle Pippin, may be successfully grown only in very restricted areas. Other varieties, such as the Baldwin, succeed over a large scope of territory, but still are adapted to only a small part of the general apple belt, while the extent of the range of adaptability of countless other varieties may be said to lie somewhere between those of the two varieties mentioned. Such limitations of variety, however, are known in a general way and with this fund of past experience available the planter need not go far astray in the selection of varieties for his orchard. In the Albemarle area, Virginia, for example, Mooney found that the York Imperial grew to the best advantage in a valley; whereas 'on the eastern side of the Blue Ridge it ripens early, and falls, and does not have as good keeping qualities.'

Again, the Albemarle Pippin[1] thrives on

[1] See Report on the Albemarle Area, U. S. Dept. of Agriculture, Field Operations of the Bureau of Soils, 1902. Report on the Mount Mitchell Area, U. S. Dept. of Agriculture, Field Operations of the Bureau of Soils, 1902. Report on the Bed-

Porter's black loam 'when this type occurs in sheltered mountain coves.' In this case the 'rich, mellow and deep' soil which this variety requires is of little avail when not in conjunction with a sheltered physiographic position which shall so determine the conditions of exposure and aeration as to produce fruit without any cloudiness or imperfection of skin, as either of these conditions detracts to a particular degree from the value of this variety in the somewhat exacting markets to which it goes.

It was also found in the Albemarle area that a loamy phase of the Cecil clay was very satisfactory for Winesap apples, but not as good for the York Imperial, though these varieties seem to do equally well on the Hagerstown loam in the valley of Virginia. If, however, lime be applied to the Cecil clay, the York Imperial is produced as successfully as the Winesap. This indicates one or both of two things: that the soil is acid and that the York Imperial can not overcome this tendency as well as the Winesap, in which case a chemical corrective is required; or that the former variety is more susceptible to the undesirable influences of a soil with texture as stiff as that of the Cecil clay, but that this textural condition is somewhat ameliorated by the application of lime.

Near the southern limit of the apple belt increased elevation so modifies climatic conditions that fruit is successfully produced between the altitudes of 2,500 feet and 3,500 feet in a latitude where at lower levels fruit does not succeed, and within the zone mentioned the climatic relations are further illustrated by the fact that near the lower elevation apples do best in coves on the north side, while in the higher mountains, where it is cooler, south coves are equally good, or perhaps even better, than the north coves.[2]

Other similar specific local problems relating to variety, surface and climatic conditions are not uncommon, and in each instance must be solved for the locality under consideration. Aside from these local qualifications, however, a most important problem which may not be evaded and is of much more general scope remains in the selection of the soil, for upon it depend in large measure the returns from a long-term investment.

In this selection of the soil the ideal to be kept ever in mind is that soil which will produce the greatest quantity of fruit of the best appearance and of the best quality for the longest possible term of years; and he who would be most successful must consider with infinite care not only each of these desiderata in its specific relation to the soil, but also the combined relation of the three to the soil in question. That is, the soil either must be naturally productive or capable of being brought to a high degree of productiveness; its inherent characteristics must be such as to produce fruit not only attractive in appearance when marketed, but also of the highest quality, if the producer is sufficiently far-sighted to recognize that in the long run the greatest profit is to come to him who from the very beginning uses his every endeavor to establish and to maintain permanently the reputation of producing the highest possible quality of fruit demanded, or for which a demand can be created, in the best markets; and finally the soil should be capable of sustaining trees in a profitable bearing condition for a long term of years.

Soils possessing one or two of these characteristics are plentiful, and a large part of the orchards already in existence not only show conclusively certain very desirable traits in such soils as exhibited in growth of tree or in character of fruit, but also indicate the importance of the other qualifications mentioned, if these orchards are to be a commercial success. This is well illustrated, for example, by orchards in the Middle States located on a deep, sandy soil (the Miami sand). This soil is found in a district noted for its successful crops of apples, yet it possesses at most but two of the required attributes. The color of the fruit produced is excellent, and the quality thereof is very good,

ford Area, U. S. Dept. of Agriculture, Field Operations of the Bureau of Soils, 1901.

[2] Report on the Mount Mitchell Area, U. S. Dept. of Agriculture, Field Operations of the Bureau of Soils, 1902.

but the soil is not of such a character as to effect a satisfactory growth of tree, and the bearing life of the tree is so short as to make it manifestly ill-advised to plant orchards upon this type of soil, except possibly to furnish a household supply of fruit.

Similar results observed upon the Norfolk sand and certain light sandy loams, and sandy gravelly loams of the Atlantic seaboard, show clearly that there is a limit in the coarseness of soil texture beyond which the soil can not be used for profitable apple culture. That this limit can be definitely established by further study, particularly if pursued in a comparative way, is, it is believed, unquestionable.

To go to the other extreme of soil texture, many clays and heavy clay loams are either productive or capable of being made so when put into the proper physical condition, and when so improved yield good crops of general farm produce. Apples grown under such conditions, however, as observed on certain fields of the Miami clay loam in Oakland County, Michigan, on the Dunkirk clay in the Champlain Valley, on the Hagerstown clay in Adams County, Pennsylvania, and on local areas of the same type in the Pikeville area, Tennessee, are inclined not only to have greasy skins, but also to be inferior in color, and so fail to command the highest prices. Furthermore, when the subsoil passes a certain stage of stiffness, namely, a texture so close that the roots do not penetrate readily and freely to a depth of several feet, satisfactory growth of tree and consequent quantity of fruit are also impossible.

That these tendencies are largely textural problems is shown on the last two types by local areas containing considerable chert or small stone fragments which serve to loosen the soil. From such areas the fruit has a much clearer and better colored skin, and the greasy characteristic is much less prevalent.

The statement is heard frequently that the apple will succeed on any soil which will produce a good crop of corn. No preconceived idea related to apple growing is more dangerous, perhaps, than this one. That good corn soils may be favorable for apple production is unquestionable, but that the opposite frequently is the case may be best illustrated, possibly, by a concrete example: The best corn soil in the United States which occurs in considerable areas is, probably, the deep, black prairie soil of the middle western states, the Miami black clay loam. But for apples it is found to be favorable only in so far as it conduces to a rank growth of tree. This tendency, indeed, is so marked upon this soil that the yield of fruit is, as a rule, materially lessened, at least until the tree has attained a considerable size. The tree, moreover, is not hardy, the color of the fruit is decidedly inferior, the grain of the fruit inclines towards coarseness, the flavor is never the best, and the keeping qualities are but mediocre. This is, of course, an extreme case, but it represents, nevertheless, a definite tendency of all that class of soils which possess in any marked degree the characteristics of this type.

Having ever in mind the ideal results already defined, as regards quantity and quality of fruit, and the extent to which they are influenced by the character of the soil *per se*, it will be interesting to develop some definite conclusion concerning the soil characteristics which contribute most fully to these ends. Discarding sands and clays for the reasons already noted, there is left a large class of soils ranging at the surface from sandy loams to clay loams, with the subsoils presenting a similarly wide range of variation.

The apple tree under favorable conditions is a vigorous grower, and has an extensive root system. Such a root system can be developed only where the soil particles are of such size and arrangement as not only to allow free root penetration to considerable depths, but also to retain such amounts of moisture as shall be favorable to root growth, and not allow available plant food to be leached away more rapidly than the tree's needs. These two characteristics, however, start from opposite textural extremes and it is only as they approach each other that a satisfactory condition exists. A light sandy subsoil allows free root penetration, but is not sufficiently retentive of moisture and dissolved plant food to supply the needs of the tree. In fact, if we

investigate a series of soils, keeping constantly our problem in mind, we shall find that the essential characteristics—such as moisture supply, retention of plant food and consequent extensive root growth—are all enhanced as the subsoil becomes heavier in texture until the stage is reached where the roots find their progress somewhat hindered mechanically. Beyond this stage of fineness in texture it is ill-advised to go, for diminished returns from the orchard will be sure to follow in proportion as this limit is exceeded. While this point of texture might be fixed theoretically, it is obvious that it may not be so decided from a practical working standpoint, and even if it could be there are probably too few soils of this exact nature in regions possessing the other favorable attributes to supply the apple trade. There are a great many soils, however, whose subsoils are sufficiently near this ideal to bring satisfactory results. Such subsoils range from very heavy sandy loams to clay loams, limited only as already mentioned, thus including the broad class of loams which increase in desirability as they approach the clay loams.

Inasmuch as the subsoils described can be depended upon largely to contain the optimum, or at least favorable, supply of moisture, and to maintain until needed a corresponding concentration of all available plant food, it follows that with them the conditions are supplied to produce a satisfactory growth of tree for a long term of years, provided a sufficient supply of plant food exists in the soil. If the surface soil be too heavy, however, any one or more of several unfavorable results might follow. When the young tree is transplanted from the nursery a great deal depends upon its ability to establish a healthy, normal and extensive root system the first year. This must be done at first within the limits of the surface soil, and is impossible of realization unless that medium is so mellow and non-resisting that the tiny roots and fibrils may be free to develop in all directions. These conditions are manifestly best obtained in soils not heavier than a medium loam nor lighter than a medium sandy loam. Ready drainage of the surface soil, which is also imperative, would be impaired if the soil were too heavy, and the detrimental effect would be apparent not only in the limited growth of tree and its ability to resist disease, but also when the tree should reach its bearing stage, in the coloring of its fruit.

The influence of the character of the soil is again felt, especially in the more northern districts, in the opportune time of the maturity of the fruit. Apples grown on light sandy soil are often ready for picking before the weather is suitable to place them in ordinary storage, while if placed in cold storage the attending expense is much greater than for fruit which matures later. On the other hand, trees grown on clay, or the heaviest clay loams, may continue their growth so late in the season that the fruit does not reach the most desirable state of maturity before it must be gathered, and the trees themselves are not so well prepared to withstand the severities of the winter climate.

The color of the fruit when harvested, furthermore, can be best only when the fruit has reached the proper stage of maturity before it must be picked. It is understood, of course, that no soil can produce highly colored fruit unless the trees are so trimmed and trained as to admit sunlight freely. Assuming that this has been done on all soils alike, and holding our comparison to data gathered under identical, or at least very similar, climatic conditions, then it may be stated that highly colored fruit may be best obtained on soils not heavier than the limit already given. Fruit of excellent color, nevertheless, may be grown on very sandy soils, as was said in connection with that class of soils, but unsatisfactory tree growth more than offsets this desirable characteristic and so eliminates such soils from serious consideration. It is thus seen that the most desirable soils from the color standpoint fall within the range of texture most desirable from the other points of view already considered.

The fact that unsuccessful orchards are frequently seen on the classes of soils already designated as desirable for apple culture most often indicates some form of neglect in methods of culture, including the mechanical con-

dition of the soil, failure to rotate crops where clean cultivation is not followed, lack of proper trimming, failure to control injurious insects, fungus diseases, etc., or that there is insufficient plant food available. Orchards are sometimes seen, however, in which all these external conditions have been carefully attended to, the trees are thrifty, and still the fruit lacks color and quality. This condition involves a chemical problem and usually indicates, as proved in numerous instances, that the supply of available potash is insufficient for the tree's needs—a lack which must be supplied by rendering available the unavailable potash already in the soil, or by the application of further material in an available form.

Another important problem arises at this point, that is, the relation, if any, which exists between diseases of various kinds to which the apple tree or its fruit is subject and the conditions, as related to the soil, under which the trees are grown. Mr. G. H. Powell, of the U. S. Department of Agriculture, stated in an address to the Western New York Horticultural Society, in 1903, that 'at the present time we would say that the practical control of the scald is primarily an orchard problem and depends on cultural conditions that develop the best and most highly colored fruit.'[3] This being the case, it appears that this malady may be avoided, in some measure at least, by selecting soils which, with other things equal, tend to produce 'the best and most highly colored fruit.' It thus seems possible, and indeed probable, that soils in themselves may have a most direct influence upon the character of the tree growth and fruit growth which shall the better enable these to resist certain forces of disease besides the scald.

That the highest quality of fruit should be obtained on a soil which produces a tree neither stunted nor too rank in growth, but normal, well developed and hardy, and consequently productive of fruit the most attractive in appearance, is a natural inference. Sufficient proof of this point, however, is not at present available, but a field of investigation is opened which will become steadily more important as the already noticeable demand for a higher quality of apples increases.

HENRY J. WILDER.

[3] See Proceedings of the 48th Annual Meeting of the Western New York Horticultural Society, 1903.

A CORRECTION OF THE GENERIC NAME (DINOCHŒRUS) GIVEN TO CERTAIN FOSSIL REMAINS FROM THE LOUP FORK MIOCENE OF NEBRASKA.

WHILE in the field during the past summer (1905) the writer sent to Dr. W. J. Holland (director, Carnegie Museum) a preliminary note on certain fossil remains of the family Suidæ from the Loup Fork Miocene of Sioux County, Nebraska. I proposed *Dinohyus hollandi* as the name and asked Dr. Holland if he would kindly look to see if that generic name was preoccupied before publishing the note. In reply Dr. Holland wrote me that *Dinochœrus* 'appears to be a better word,' and that it was not preoccupied. I agreed to the change, but find that the name *Dinochœrus* has been used by Gloger, for a South African hog (*Hand- und Hilfsbuch Naturgeschichte*, I., pp. xxxii, 131, 1841), and, therefore, propose my original name *Dinohyus hollandi* for the fossil remains, which was published in SCIENCE, N. S., Vol. XXII., No. 555, pp. 211–212, August 18, 1905.

O. A. PETERSON.

CARNEGIE MUSEUM,
October 24, 1905.

QUOTATIONS.

ACADEMIC FREEDOM IN JAPAN.

PROFESSOR TOMIZU, most eminent of Japanese authorities on Roman law and professor in the Imperial University, Tokio, has lost his chair, arbitrarily removed by the minister of education, owing to his passionate denunciation of the ministry for the terms which it authorized Japan's representatives at Portsmouth to accept. He is one of a group of seven professors in the university who have been critical of the ministry ever since the war with Russia began.

Professor Tomizu's eminence together with the radical nature of the government's con-

duct, have stirred twenty professors in the university and not a few other teachers to memorialize the minister of state for education. They insist that the competency of Professor Tomizu to hold his chair and his personal character and general conduct are the main points for a minister of education to consider, and not his political opinions from which the ministry and many others may differ. They contend, moreover, that there is nothing in the rules laid down for civil officials, which authorizes the treatment of a man with a university professor's status in such a way.

This appeal represents the convictions of some of the most eminent names in Japan's list of pedagogues and scientists, who, however much they wish a renewal of Professor Tomizu's right status, care even more for the principle involved and the precedent established, a precedent contrary, they believe, to the best educational and political interests of the land. They realize that if Professor Tomizu can be summarily discharged by a minister of education on this issue, they may be discharged at any time on other issues.

In this country academic opinion usually is favorable to peace and hostile to war and extreme measures. In Japan, during the recent conflict with Russia, academic opinion has been conspicuous for a belligerency of spirit.

Japan's surviving autocracy and absolutism under parliamentary forms, has enabled the ministry in its dealing with journalists to be as severe and peremptory as public welfare seemed to make necessary. Professor Tomizu has felt the same iron hand, conserving the interests of peace, at a time when popular feeling has run high and strong.—*The Boston Transcript.*

NOTES ON ENTOMOLOGY.

SEVERAL fascicles of Wytsman's 'Genera Insectorum' have recently been issued; some of much interest to American entomologists. Fascicle 22 treats of the Braconidæ; it is in two parts, of 253 pages and 3 colored plates; it is written by Gy. V. Szépligeti. His classification is, in the main, that of Dr. Ashmead, but he has added several new genera.

Fascicle 23 deals with the Crioceridæ, a group of chrysomelid beetles. M. Jacoby and H. Clavareau are the authors, and the paper contains 40 pages and 5 colored plates. Most of these forms are exotic.

Fascicle 24 is on the subfamily Scutellerinæ of the family Pentatomidæ. It is by H. Schouteden, and occupies 98 pages and 5 colored plates. Most of the species are from the tropics.

Fascicle 25 is by J. Desneux on the Termitidæ or white ants. There are 52 pages and 2 colored plates. He has given a very complete catalogue of the family. His sinking of the many new genera recently created at the expense of the old genus *Termes* is to be highly commended, although he admits that the genus may be divided into six subgenera.

Fascicle 26 is devoted to the Culicidæ, or mosquitoes; F. W. Theobald is the author. There are 50 pages and 2 colored plates. One notices the omission of several species described by Miss Ludlow, and other American entomologists. Apparently ignorant of their identity, Mr. Theobald retains both *Pelorempis* and *Eucorethra* as distinct genera, and even finds characters to separate them in the table.

A USEFUL article is that by Mr. M. T. Cook on the insect galls of Indiana.[1] It includes a general treatment of galls, a catalogue of the Indiana species, with a brief description, and often figure, of the gall, ending with a bibliography. The insects are not described. The enthusiastic author appears, unfortunately, to have but a slight acquaintance with the European literature on cecidii.

MAJOR T. L. CASEY has revised another large group of American beetles; the tribe Pæderini of the family Staphylinidæ.[2] The generic synopses include all American genera, but the specific tables include only the species from the United States. Many of the genera are described as new, and there are many notes on the position of genera, and suggested improvements in the accepted classification.

[1] 'The Insect Galls of Indiana,' 29th Ann. Rept. Dept. Geol. Indiana, 1904, pp. 801–867, 52 figs.

[2] 'A Revision of the American Pæderini,' *Trans. Acad. Sci. St. Louis*, XV., pp. 17–248, 1905.

Several of our species, previously considered identical with European forms, he finds, upon comparison, are distinct therefrom. Over two hundred species are described as new.

It is not often that catalogues of exotic insects are issued by Americans; therefore, Mr. Levi W. Mengel's catalogue[3] of the Erycinidæ is all the more noteworthy. It is printed in double columns; necessary references, with dates, and synonymy are given; the species are numbered in the genera; there is a full index; in short it is a very useful work to the student of butterflies the world over.

Mr. Lewis's catalogue of the Histeridæ, a family of beetles, will be a great boon to all who wish to study the group.[4] It is a pamphlet of 81 pages, and lists 2,306 species. It appears to be complete, but, unfortunately, there are a few errors in localities and references. Mr. Lewis's collection of these insects is by far the most valuable in the world.

A large treatise on mosquitoes has been published by Professor R. Blanchard.[5] It at once reminds one of Giles's English work, but is not as technical. Part I. treats of the morphology, anatomy, habits, metamorphoses and parasites of mosquitoes. Part II. is a systematic synopsis and list of all the known species. He decides that the proper name of the yellow fever mosquito is *Stegomyia calopus* Meigen, 1818. Part III. relates to the medical phase of the subject. Mosquitoes are considered as agents in malaria, yellow fever, filariasis, and in their probable relation to other diseases. There are chapters on methods of destroying larvæ and adults, of abolishing their breeding-places, of curing the diseases, and finally on rearing and preparing specimens. An appendix includes a list of recently-described species, and a long bibliography. Photographs of Ross, Finlay, Manson and Grassi adorn the pages. Many of the text figures are from Dr. Howard's works.

[3] 'A Catalogue of the Erycinidæ,' Reading, Pa., May, 1905, pp. 161.

[4] 'A Systematic Catalogue of Histeridæ,' by George Lewis; Taylor and Francis, London, 1905.

[5] 'Les moustiques, histoire naturelle et médicale,' Paris, 1905, pp. 673, figs. 316.

An elaborate book on the Anopheles mosquitoes of India is that by Messrs. S. P. James and W. G. Liston.[6] Part I. treats of the habits, external anatomy, breeding-places and methods of studying this genus of mosquitoes. Part II. consists of technical descriptions of 23 species, arranged in 10 groups. Very sensibly he neglects to make new genera for these groups. A number of larvæ are described and figured, with details. There are many plates, 15 of which are colored and printed on a green background, quite a novel feature in entomology.

An interesting arrangement of the genera of Vespidæ, or true wasps, is that by A. Ducke.[7] He believes that the nesting-habits is the clew to the natural classification, and tabulates the South American forms on this basis. Some of the older genera are divided, and he has added descriptions of a few new forms. The plate represents the nests of two species of *Charterginus*, showing the opening on the upper side.

Dr. W. A. Schulz has issued a separate publication under the title 'Hymenopteren-Studien.'[8] It consists of three parts: First, a list of Hymenoptera collected in various parts of North Africa, with notes and descriptions of new forms; second, new genera and species of Trigonalidæ, describing, at great length, several new types from South America; and third, a list of some Vespidæ and Apidæ from the Amazon region, with descriptions of a few new species.

Nathan Banks.

BOTANICAL NOTES.

INDEX OF NORTH AMERICA FUNGI.

For many years, Professor Dr. Farlow, of Harvard University, has had under preparation an index of the species of North American fungi which should serve as a guide to the more important systematic literature. The

[6] 'A Monograph of the Anopheles Mosquitoes of India,' Calcutta, 1904, 132 pp., many plates.

[7] 'Nouvelles contributions a la connaissance, des Vespides sociaux de l'Amerique du Sud,' *Rev. d'Entom.*, 1905, pp. 5–24, 1 plate.

[8] Leipzig, W. Engelmann, 1905; 147 pp., 13 text figs.

results of these labors are now shown in the first fascicle (Vol. I., part 1) of the 'Bibliographical Index of North American Fungi' which appears as 'Publication No. 8' of the Carnegie Institution of Washington. The author does not include references to merely economic papers, such as those 'on fungicides and other technical and agricultural subjects,' although even these are cited when they contain notes of interest to the systematist. Likewise, papers relating to the physiology and cytology of the fungi are not included (with some exceptions) nor is the literature of the bacteria and saccharomycetes cited.

The arrangement of the genera is alphabetical, with an alphabetical arrangement of the species under each genus. Under each species, the literature is cited in chronological order. As to classification and nomenclature, the author has been conservative, having 'tried as far as possible to avoid changing names in common use for many years.' The 'Sylloge Fungorum' of Saccardo, and the 'Pflanzenfamilien' of Engler and Prantl have been followed as far as possible. While admitting that 'the present classification of fungi is not one which can be called more than temporary,' the author feels that our knowledge of the fungi of the world is not yet sufficient to make it possible 'to form a really natural and scientific system.'

While following the law of priority in regard to specific names, the author 'has no scruples in declining to accept many of the names of older writers which have of late been substituted for more modern names, since, from the vagueness of the descriptions and the crudeness of the illustrations, it is impossible, in the absence of original specimens, to be sure that the species were the same as those to which they have since been applied.'

In this connection, the significant and pertinent remark is made that "it is best not to make too violent attempts to interpret the older mycologists, but to be content with letting the dead bury their dead. The business of reviving corpses has been carried altogether too far in mycology.' Incidentally, he hopes that the next botanical congress will make a list of names of cryptogams which are to be regarded as fixed and exempt from further changes on the grounds of priority.

From remarks in the preface, we infer that the successive parts may be expected to appear without much delay, although it must necessarily take a good deal of time to revise the manuscript and see it through the press. When completed, it will be invaluable to the working botanist, and it is to be hoped that it can be pushed through the press with all possible speed.

THE FERN ALLIES OF NORTH AMERICA.

PROFESSOR WILLARD N. CLUTE has earned the thanks of naturalists of all kinds, from amateurs to professional botanists by bringing out his book, 'The Fern Allies' (Frederick A. Stokes Co., New York), in which, by means of illustrations and non-technical descriptions, he gives a popular account of the plants which are related to the ferns. They include seven families, namely; *Equisetaceae* (14 species), *Lycopodiaceae* (13 species), *Psilotaceae* (1 species), *Selaginellaceae* (12 species), *Salviniaceae* (3 species), *Marsiliaceae* (5 species) and *Isoetaceae* (21 species). There are thus sixty-nine species described in this book, and, since every species is figured at least once, it is easy to see how useful a book this will be for the general reader and the amateur, while at the same time it is likely to prove handy for the professional botanist also. Good keys to the species are given in each family. At the end of the volume is an alphabetical check-list of North American Fern Allies, including many varieties, and this is followed by a simple glossary. The book is well printed and neatly bound, and deserves a wide sale among all classes of plant lovers.

THE GRASSES OF IOWA.

FOUR years ago, the first volume of 'The Grasses of Iowa' appeared as Bulletin No. 1 of the Iowa Geological Survey. That volume was prepared under the joint authorship of Professors Pammel and Weems, of the Iowa Agricultural College, and F. Lamson-Scribner, of the United States Department of Agriculture, and was devoted to a general discussion of the structure, pathology and economic uses

of the grasses. A second volume has now appeared, bearing the date 1904 on the title page, but with a preface dated April 1, 1905. It is also the joint work of several authors, namely, Professor Pammel, C. R. Bell and F. Lamson-Scribner, the two latter of the United States Department of Agriculture. This volume is almost entirely systematic, including descriptions (and usually figures) of about two hundred species and varieties that are native to Iowa or are grown more or less commonly under cultivation. Short chapters on the physiography and geology of Iowa by Dr. H. F. Bain, and the ecological and geographical distribution of Iowa grasses, by Professor Pammel, and a bibliography, close the volume. The two volumes must prove of great value to the farmers of the state, and the second one especially must be helpful to students and others who are interested in the grasses.

It is unfortunate that the public printer should not have done better by these volumes. Paper, type, proof-reading and binding are poor, and are quite unworthy of the text. The authors as well as the people of the great state of Iowa have a right to something much better.

EXPERIMENTS WITH PLANTS.

YEAR by year, one can see that progress is made in the study of plants and their activities. Instead of learning the systematic classification of a plant, alone, as we used to a generation ago, or making out only its microscopic mechanism, as we did later, we are now shown how we may find out what plants and their different organs are doing at different times in their lives. In a suggestive book, 'Experiments with Plants,' Professor Dr. Osterhout, of the University of California, shows teachers how they may ask many questions of plants in such a way as to have them answered by the plants themselves. In ten chapters, the author takes up as many different subjects as follows: the awakening of the seed, getting established, the work of roots, the work of leaves, the work of stems, the work of flowers, the work of fruits, how plants are influenced by their surroundings, plants which cause decay, fermentation and disease, and making new kinds of plants. By a series of simple experiments, usually with simple and often home-made apparatus, the author enables the student to find out a great many things about plants. More than two hundred and fifty illustrations, make still plainer the very clear directions given for making the experiments, and in both, there is evidence of the author's ingenuity in planning devices for experimental purposes.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

INTERNATIONAL EXPLORATION OF THE NORTH SEA.[1]

IT would be difficult to estimate in terms sufficiently emphatic the vast, momentous importance which attaches to the great international investigations at present being carried out in regard to the fisheries of the North Sea and adjacent waters. At a conference of delegates held at Stockholm in 1890 (at the instance of the King of Sweden and Norway) a general plan for instituting inquiries was drawn up, which it was confidently asserted would undoubtedly lead to the attainment of a better and much more extended knowledge of the natural history of fishes and the influences which regulate their movements to and fro. At a second conference held at Christiania in 1901 a program of work was formulated, to which the several governments acceded, and in the summer of 1902 operations for the great international scheme—the exploration of the sea—were begun.

The nations engaged in the investigations conjointly with Great Britain, include Belgium, Denmark, Finland, Germany, Holland, Norway, Sweden and Russia. Each country, we are told, sends representatives to a central council, which is located in Copenhagen under the presidency of Dr. Walter Herwig, of Hanover, and the vice-presidency of Professor Otto Pettersson, of Stockholm. Every endeavor has been made to ensure that the investigations are carried out in as thorough a manner as possible. The ground of inquiry extends over a very extended sea area, and involves the elucidation and confirmation regarding various points connected with the

[1] The London *Times*.

phenomena of the sea, of which at present we possess a somewhat limited knowledge.

In carrying on the manifold and intricate investigations regarding the hydrographical and fish-yielding mysteries of the sea each country has its own laboratories and scientific staff, and has also at command one or more steamers. In some cases a hired vessel for temporary use is employed (Great Britain has to be content with one); but in others, as in Germany, Russia, Norway, Sweden and Denmark, special steamers have been built, provided with accommodation for a large scientific staff, and elaborately equipped with scientific appliances and fishing gear. At the central laboratory at Christiania, under the direction of Professor Fridtjof Nansen, the hydrographic apparatus required by the different countries is regulated and distributed. The chemical analyses are checked and controlled, and various hydrographical researches of a special and difficult kind are undertaken.

GREEK AT CAMBRIDGE.

The chairman and secretaries of the committee in support of the recommendations of the studies and examinations syndicate making Greek optional in the entrance examination at Cambridge have addressed the following letter to the editor of the London *Times:*

Of the Graces submitted to the senate of the University of Cambridge on March 2, 3 and 4 last, for the confirmation of the report of the Studies Syndicate, Grace 2 was the most important and the most eagerly contested. It was this Grace which directly proposed to make Greek optional in the previous examination.

The number of members of the electoral roll who are members of the senate—that is, practically, the resident members of the senate—was about 600. In the whole constituency there were about 7,000 voters. The votes were—placet 1,055, non-placet 1,557.

A careful analysis of the poll-book gives the following results:

1. Of the residents, 288 voted in favor of the recommendation that Greek should no longer be compulsory in the previous examination; 240 voted against the recommendation—majority of residents in favor of the recommendation, 48.

2. Of the total number of members of the senate who voted, residents and non-residents included, 1,591 were laymen, 1,021 were clergymen.

Of the laymen, 923 voted in favor of the recommendation; 668 voted against it—majority of laymen in favor of the recommendation, 255.

Of the clergymen, 132 voted in favor of the recommendation; 889 voted against it—majority of clergymen against the recommendation, 757.

THE AMERICAN PSYCHOLOGICAL ASSOCIATION.

According to the preliminary announcement issued by the secretary of the American Psychological Association, Professor Wm. Harper Davis, of Lehigh University, the fourteenth annual meeting will be held at Harvard University on December 27, 28 and 29, in affiliation with the American Philosophical Association.

After the formal opening of Emerson Hall, where the associations will meet in joint session on the afternoon of Wednesday, December 27, to hear addresses by President Eliot and Dr. E. Emerson, a formal joint discussion will be held 'On the Affiliation of Psychology with Philosophy and with the Natural Sciences.' Professor Fullerton, President Hall, Professor Münsterberg, Professor Taylor, Professor Thilly and Professor Witmer have consented to speak.

A conference of the association has also been arranged to consider the subject of 'Cooperation between Laboratories and Departments of Different Institutions.' This will also be thrown open for general discussion. It is possible that another discussion, either on a strictly psychological subject or on the content of undergraduate instruction in psychology, will be arranged for.

Luncheon will be served on Wednesday, December 27, by the Harvard Corporation. After the address of the president, Professor Mary Whiton Calkins, of Wellesley College, on Wednesday evening, a general reception will be held at the residence of Professor and Mrs. Münsterberg, and following the presidential address before the American Philosophical Association, by Professor John Dewey, of Columbia University, a joint smoker will be held in the Harvard Union.

Through the kindness of Harvard students of psychology and philosophy, a limited number of dormitory rooms in Cambridge have been placed at the disposal of the Harvard department for assignment to members of the visiting associations. By the courtesy of the Bertram Hall committee and of Radcliffe students, twenty rooms in Bertram Hall, the Radcliffe College dormitory, will be placed at the disposal of women attending the meetings, preference being given to regular members of the association.

SCIENTIFIC NOTES AND NEWS.

SIR JOHN SCOTT BURDON-SANDERSON, formerly Waynflete professor of physiology and regius professor of medicine at Oxford, has died at the age of seventy-seven years.

DR. GEORGE H. DARWIN, F.R.S., Plumian professor of astronomy and experimental philosophy at Cambridge, has been knighted by King Edward.

THE Southeastern Passenger Association has granted a rate of one fare plus twenty-five cents to those attending the New Orleans meeting of the American Association for the Advancement of Science. Other roads will probably make similar arrangements.

THE American Chemical Society will meet in New Orleans in connection with Section C of the American Association for the Advancement of Science from December 29 to January 2, 1905–06. The president of the society is Dr. Francis P. Venable, of Chapel Hill, N. C., the secretary, Dr. William A. Noyes, of the Bureau of Standards, Washington, D. C. The chairman-elect of Section C is Professor Charles F. Mabery, of the Case School of Applied Science, Cleveland, O., the secretary is Professor Charles L. Parsons, of Durham, N. H.

THE Botanical Society of America will meet in New Orleans from January 1 to 4, 1906, under the presidency of Professor R. A. Harper, of the University of Wisconsin. The headquarters are at the Hotel St. Charles, and the sessions will be held in the rooms of Tulane University. Mr. Frederick V. Coville, the retiring president, has chosen as the subject of his address 'Botanical Explorations in Alaska.'

PROFESSOR V. F. BJERKNES, of the University of Stockholm, has arrived in this country to give the course of lectures at Columbia University that has already been announced.

A TESTIMONIAL banquet was given to Dr. Nicholas Senn, at the Auditorium Hotel, Chicago, on November 11, with about seven hundred physicians in attendance. Dr. Joseph D. Bryant, of New York City, presented a gold medallion to Dr. Senn, miniature replicas of which were distributed among those in attendance. On one side of the medallion was a likeness of Dr. Senn; on the other the inscription: "To Nicholas Senn, the Master Surgeon, from his Fellows, November 11, 1905." Dr. L. G. Nolte, of Milwaukee, Wis., presented Dr. Senn with a silver loving cup, given by his former private pupils.

PROFESSOR JACOB REIGHARD, of the University of Michigan, lectured on 'The Habits of Fishes' at the University of Kansas on November 16. This lecture was under the auspices of the Sigma Xi Society of the university. On Friday morning following he gave the convocation address before the students and faculty upon the subject of 'Instincts of Man.' On Friday evening Dr. Reighard was the guest of honor at a reception, giving him an opportunity to meet the faculty of the university.

DR. W. A. NOYES, of the U. S. Bureau of Standards and editor and secretary of the American Chemical Society, lectured last week before the chemical students of Lafayette College, Easton, Pa., on 'The History of the Discovery of the Composition of Water.'

DR. MAXIMILLIAN MAURER has been appointed director of the Meteorological Station of Zurich.

DR. WILHELM WUNSTORF has been appointed geologist in the Berlin Geological Bureau.

PROFESSOR KOEHLER, the president of the Imperial Bureau of Health at Berlin, has retired.

THE members of the council of the Royal Society for the ensuing year, in addition to

the officers, are as follows: Dr. Shelford Bidwell, Sir T. Lauder Brunton, M.D., Professor J. Norman Collie, Ph.D., Professor Wyndham R. Dunstan, M.A., Professor John Bretland Farmer, M.A., Professor Francis Gotch, D.Sc., Dr. Sidney Frederic Harmer, Sir William Huggins, K.C.B., Professor Edwin Ray Lankester, M.A., Dr. John Edward Marr, Mr. George Ballard Mathews, M.A., Mr. Hugh Frank Newall, M.A., Sir William Davidson Niven, K.C.B., Professor John Perry, D.Sc., Professor Ernest Henry Starling, M.D., Professor William Augustus Tilden, D.Sc.

Sir Frederick Treves gave the opening address of the winter series of the Edinburgh Philosophical Institution on October 31, Lord Rosebery presiding.

A general monthly meeting of the members of the Royal Institution was held on November 6, Sir James Crichton-Browne, treasurer and vice-president, in the chair. The special thanks of the members were returned to Mr. Robert Hannah, M.R.I. for his gift of the picture, painted by him, of 'Master Isaac Newton in His Garden at Woolsthorpe, in the Autumn of 1665.' A Christmas course of lectures, adapted to a juvenile auditory, will be delivered at the Royal Institution by Professor Herbert Hall Turner, F.R.S., on 'Astronomy.' The dates of the lectures are December 28, 30, 1905, January 2, 4, 6 and 9, 1906, at 3 o'clock.

The statue of Benjamin Silliman has been removed from its site on the old campus of Yale University, near the library, to a place between the Sloan and Kent laboratories.

On October 13 a bust of the late Professor M. Nencki was unveiled in the chemical department of the Institute of Experimental Medicine, St. Petersburg. Professor Pawlow delivered an address.

A memorial to Theodore Schwamm, regarded as the originator of the cell theory, is to be erected in his native birthplace, Reuss. The sum of $2,500 has already been collected for this purpose, but an additional sum of equal amount is wanted. It is proposed to create a scholarship as part of the memorial.

Professor John Lewis Morris, emeritus Sibley professor of practical mechanics and machine construction at Cornell University, died on November 19, at the age of sixty-three years.

The death is announced of Mr. W. H. Andrews, assistant chemist in the New York State Agricultural Station at Ithaca.

Dr. Gustave Dewalque, formerly professor of geology at Liège, died at Liège on November 3, in his eightieth year.

Dr. E. Oustalet, professor of zoology in the Natural History Museum at Paris, has died, at the age of fifty-one years.

Freiherr von der Goltz, director of the Agricultural Academy at Poppelsdorff and professor of agriculture at the University of Bonn, died on November 6, at the age of seventy-eight years.

The death is also announced of Dr. W. P. Amalizki, professor of geology and paleontology at Warsaw, and of Professor Bernhard Fischer, director of the chemical research laboratory at Breslau.

The late Stephen Salisbury, of Worcester, Mass., has bequeathed the residue of his estate to the Worcester Art Museum, which, it is said, will receive more than $3,000,000. Many other public bequests have been made by the will, including, in addition to $200,000 to the Worcester Polytechnic Institute, some $250,000 to the American Antiquarian Society and $5,000 and a site for a building for the Worcester Natural History Society.

The executive committee of the National Educational Association authorizes the announcement that the forty-fifth annual meeting will be held in San Francisco, Cal., from July 9 to 13, 1906. The lines of the Transcontinental Passenger Association have authorized a rate of one lowest first-class limited fare for the round trip plus $2, National Educational Association membership fee *viâ* direct routes; this provides for going one route and returning another. For tickets routed *viâ* Portland, Oregon, in one direction the rate will be $12.50 higher. The dates of sale will extend from June 25 to July 7, and the return

limit will be September 15. Stop-overs will be allowed west of the Missouri River and St. Paul on both the going and return trips. As has already been announced, the department of superintendence will hold its next meeting in Louisville, Ky., February 27 and 28 and March 1. Superintendent John W. Carr, president of the department, is formulating the program which it is expected will be issued early in December.

THE next meeting for the Australasian Association for the Advancement of Science will be held in Adelaide during January, 1907.

THE next meeting of the German Society of Experimental Psychology will be held at Würzburg on April 10 to 13. Reports will be presented on the following subjects: (1) the relations between experimental phonetics and psychology, by E. Krueger; (2) experimental esthetics, by O. Külpe; (3) the psychology of reading, by F. Schumann; and psychiatry and individual psychology, by R. Sommer.

THE International Congress on Milk Supply will hold its third congress at The Hague in 1907.

AN American Bison Society has been organized in New York City to take steps to prevent the extermination of the buffalo. The New York Zoological Society is prepared to give a herd of buffalos to be placed on the Wichita forest reserve in Oklahoma.

THE Nicholas Senn Club for Scientific Research has been incorporated in Chicago by Drs. Byron Robinson, Orville W. Mackellar and Arthur McNeal.

THE second session of the Graduate School of Agriculture will be held in the summer of 1906 at the agricultural college of the University of Illinois, under the auspices of the Association of American Agricultural Colleges and Experiment Stations and the University of Illinois.

THE Keep Commission is now investigating the Crop Department Bureau of the Department of Agriculture, of which no chief has been appointed since the resignation of Mr. John Hyde. It is said that the bureau may be abolished, its work being divided between the Weather Bureau and the Census Office.

AT the instance of Professor Robert Fletcher, director of the Thayer School of Civil Engineering, and of the president and faculty of Dartmouth College, a series of lectures has been delivered to the engineering students on 'The Economics of Transportation and on Physical Hydrography,' by Professor Lewis M. Haupt, Sc.D., in which it was shown that the annual freight bill paid for overland transportation in the United States, exclusive of waterways, amounted to the enormous sum of $2,600,000,000, and that although the United States has the lowest average tariff per ton-mile in the world, yet the European railways are able to charge from two to three times as much, with greater profits and still compete with this country for the foreign commerce of the world, because of their improved system of waterways. These facts serve to impress the benefits to all classes of carriers and producers resulting from the utilization of water routes for the raw and bulky materials of low values—not yet sufficiently appreciated by traffic managers of this country. The annual saving which might be effected by the betterment of the common roads as feeders was estimated to be enough to pay all the expenses of the government and the desirability of a much more rapid expansion of commercial channels to keep pace with the growth of vessels was forcefully presented.

UNIVERSITY AND EDUCATIONAL NEWS.

BY the will of the late Stephen Salisbury the Worcester Polytechnic Institute receives a bequest of $200,000. This money comes without restrictions of any kind on the part of the testator. In addition to this bequest Mr. Salisbury, at the time of his resignation a few weeks ago from the presidency of the board of trustees, made an additional gift to the institute of $100,000, to be paid immediately.

FORMAL announcement of the $250,000 legacy to the Sheffield Scientific School from the estate of the late M. D. Viets, of Granby, has been made by Professor Russell H. Chittenden, director of the school. The bequest will

be used for the physical, mathematical and general scientific needs of the school.

THE late Frank Harvey Cilley, the engineer, has bequeathed the residue of his estate, which will probably amount to $70,000, to the Massachusetts Institute of Technology for the purchase of suitable books, photographs, casts, anatomical models and statuary for the library and gymnasium of the proposed Walker Memorial Gymnasium, or for special lectures on physical culture.

MR. T. P. SHONTS, chairman of the Isthmian Canal Commission, has given to Monmouth College $10,000 as part of the $30,000 needed to obtain an additional $30,000 which Mr. Andrew Carnegie had promised to give the college for a library.

THE foundation is being laid for the north wing of University Hall, of the University of Wisconsin, which, when completed, will almost double the class and lecture room capacity of that building. The new wing will be ready for occupancy at the beginning of the next academic year. The regents of the university have purchased the large lot on the corner of State and Park streets opposite the University Library and the Assembly Hall, as a site for the new administration building. The plans for the new building have not been completed as yet and work will probably not be begun until next spring.

The Experiment Station Record states that with the inauguration of a four-year course of study at the agricultural high school of Vienna, the right has been given the school to confer the doctor's degree (*'Doktor der Bodenkultur'*). The course was formerly a three-year one, and there has long been an effort to raise the grade of work done by the school. The present action places it on a par with the universities and technical high schools.

EXCHANGES state that the Carnegie College of Hygiene at Dunfermline was formally opened on October 4. The course of study is very comprehensive. The college year is divided into three terms of twelve weeks each, and the work is divided into two sections—theoretical and practical—which, in turn, are subdivided. The theoretical includes human anatomy and physiology, personal and school hygiene, theory of movements and teaching, symptomatology in connection with remedial gymnastics and school hygiene, and voice production. The practical course includes (1) educational gymnastics—Ling's Swedish system, (2) remedial gymnastics and massage, students being allowed, under medical supervision, to treat cases; (3) methods of class teaching, students having charge, under supervision, of classes of all ages in the public schools and in the gymnasium; (4) games, dancing and swimming.

THE REV. DAVID H. BUELL, professor of physics in Georgetown University, has been elected president of the institution.

PROFESSOR H. B. DATES, dean of the Engineering School of the University of Colorado, has accepted a professorship of electrical engineering at the Case School of Applied Science.

PROFESSOR THEODORE WHITTLESEY, for some years connected with the department of chemistry, Cornell University, and more latterly adjunct professor of chemistry in the School of Pharmacy of Northwestern University, has recently been appointed adjunct professor of chemistry in Northwestern University.

MR. F. J. SEAVER has been appointed professor of botany in Iowa Wesleyan College.

THE following appointments are noted in *The Experiment Station Record:* J. B. Davidson has been elected assistant professor in agricultural engineering at the Iowa College to succeed C. J. Zintheo, who resigned to take up work in farm mechanics in connection with the irrigation and drainage work in charge of the Office of Experiment Stations. E. T. Robbins has been elected to the position of assistant in animal husbandry, to succeed W. W. Smith, who has been elected assistant of animal husbandry at Purdue University. At the North Carolina Station W. F. Massey has resigned his position as horticulturist and will devote himself to editorial work. O. L. Bagley and R. H. Harper, graduates of the class of 1905, have been appointed assistant chemists to the station.

DR. OTTO STOLZ, professor of mathematics at Innsbruck, has retired.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, DECEMBER 8, 1905.

CONTENTS.

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y

UNIVERSITY REGISTRATION STATISTICS.

A COMPARISON of the enrolment at the institutions indicated in the table for the fall of 1905 with the figures for the previous year will show that on the whole the gains in the different institutions are not so marked as they have been in previous years; indeed, a number of prominent institutions show a decrease in attendance compared with 1904. Among these are the University of California, Columbia, Harvard, Johns Hopkins, Northwestern and Princeton. The most consistent gains have been made by the University of Pennsylvania, Syracuse and Yale in the east, and by Chicago, Illinois, Michigan and Ohio State in the west. The most pleasing feature of the development is the general desire all along the line to advance the standard of requirements for entrance, particularly in the professional schools, and in a considerable number of institutions the decrease in registration may be attributed to this factor. The daily press is still commenting upon the growth of the western institutions and calling attention to a loss in the number of students from the west attending higher institutions of learning in the east. As was pointed out by the writer in an article on the geographical distribution of the student body at a number of American universities,[1] there has in reality been no ap-

[1] Cf. SCIENCE, N. S., Vol. XXII., No. 562, October 6, 1905, pp. 424–428.

FACULTIES	California	Chicago	Columbia	Cornell	Harvard	Illinois	Indiana	Johns Hopkins	Leland Stanford, Jr.	Michigan	Minnesota	Missouri	Nebraska	Northwestern	Ohio State	Pennsylvania	Princeton	Syracuse	Virginia	Wisconsin	Yale
College Arts, Men	532	750	557	} 694	1898	352	493	188	907	886	470	319	263	368	266	305	629	} 1213	246	881	1323
College Arts, Women	943	893	371		356	376	299		488	641	843	281	640	463	254					653	
Scientific Schools*	764		566	1499	507	880	†		†	1152	576	562	566	†	766	608	624	391	110	771	1028
Law	76	133	277	220	709	144	178		140	868	455	199	186	214	147	323		160	189	149	277
Medicine	72	153	424	362	290	540	26	293		334	191	94	105	486		580		151	121		137
Graduate Schools	271	420	804	200	456	145		160	68	123	125	92	93	49	37	287	108	65	30	258	372
Agriculture	111			222	27	350					800	97	154		208					142	
Architecture	12		107	81	§	110									10	123		44			
Art	165				‖	14						†	49					107			49
Dentistry	76				86	144				130	181			391		325					
Divinity		177			36									256							88
Forestry	**				§							**			17						57
Music	†		32		‖	88						††	320	336		38		618		229	85
Pedagogy	†	163	792		‖	§§						207						†		65	
Pharmacy	82		353			172				69	75			167	50					31	
Veterinary				88								**			114	100					
Other Courses		168		199		38		47		82	14		200	114	45	621		44			
Deduct Double Registration		(175)	(266)	(1)	(15)					(201)		(226)	(72)	(95)		(8)		(70)		(434)	(177)
Total	3104	2682	4017	3564	4350	3353	996	688	1603	4084	3730	1625	2504	2749	1914	3302	1361	2723	696	2745	3239
Summer Session (1905)	795	2293	1018	619	1076	423	622		33	690	210	396	211	194	296	214		88		531	288
Deduct Double Registration	(268)	(418)	(280)	(312)	(143)	(141)	(241)		(30)	(253)		(134)	(80)	(152)	(153)	(86)		(35)		(193)	(50)
Grand Total, 1905	**3631**	**4557**	**4755**	**3871**	**5283**	**3635**	**1377**	**688**	**1606**	**4521**	**3940**	**1887**	**2635**	**2791**	**2057**	**3430**	**1361**	**2776**	**696**	**3083**	**3477**
" " **1904**	3738	4035	4833	3833	5392	3369	1206	740	1424	4000	3886	1704	2728	2856	1758	3027	1385	2452	691	3370	3008
" " **1903**	3690	4146	4557	3438	6013	3239	1614	694	1370	3926	3550	1540	2513	2740	1710	2644	1434	2207		3221	2990
" " **1902**	3676	4296	4156	3281	5468		1648	669	1378	3764	3505	1408	2560	2875		2549	1345	2020		2884	2804
Officers	364	316	573	480	569	396	80	173	145	305	231	148	168	345	160	345	157	207	83	271	414

* Includes schools of chemistry, engineering, mining and related departments.

† Included in college statistics. § Included in scientific schools.

‖ Not a separate school; courses taken by undergraduate and graduate students in college or scientific school and graduate school, respectively.

** Included in agriculture. †† Included in pedagogy. §§ 92 students included in other departments.

preciable falling off in the percentage of western students in attendance on eastern institutions, and this statement is borne out at Yale, for example, this year, the university reporting gains in the west and northwest, and the same increase holds true for Columbia. In the case of the latter institution, the erection of dormitories is no doubt partly responsible for this growth in the number of students hailing from the middle and far west. Unquestionably the low tuition fees at the western state institutions are responsible in large measure for the consistent gains made by most of these institutions in the matter of attendance.

The statistics given on page 730 are, with minor exceptions, approximately as of November 1, 1905, and relate to the registration at twenty-one of the leading universities throughout the country. I wish again to point out that the higher institutions here represented are not the twenty-one largest nor the twenty-one leading universities of the country. The figures have in every case been secured from the proper officials of the university concerned. At the majority of the institutions the final enrolment at the close of the year will no doubt be in excess of the figures given in the table, but changes of this nature made in the course of the academic year are as a rule not of sufficient magnitude to influence the general result. A number of newspapers have published comparative tables this fall which have been thoroughly misleading, inasmuch as they were based upon returns that were altogether too early. To mention just one illustration, an article in the Boston *Transcript* for October 14, 1905, enumerated the American universities having the largest student enrolment (exclusive of the summer session registration) in the following order: Michigan, Harvard, Minnesota, Columbia, Pennsylvania, California, Yale, Cornell, etc.; whereas the later figures show that it should have been Harvard, Michigan, Columbia, Minnesota, Cornell, Illinois, Pennsylvania, Yale, etc.

According to the figures of 1904, the twenty-one universities included in the comparison ranked as follows: Harvard, Columbia, Chicago, Michigan, Minnesota, Cornell, California, Wisconsin, Illinois, Pennsylvania, Yale, Northwestern, Nebraska, Syracuse, Ohio State, Missouri, Leland Stanford, Princeton, Indiana, Johns Hopkins and Virginia. Comparing this with the 1905 order, we notice that there has been no change in the relative positions of the six universities having the largest total enrolment, that is, counting in the summer session registration. Illinois, however, has passed California, although the registration at the two universities is practically identical. The fact that Yale has passed the University of Pennsylvania is due to the establishment of a summer session at the former institution, but there is very little difference in the enrolment of the two universities. The Wisconsin figures for this year do not include the dairy students and short-course students in agriculture, which were included in previous years; this does not, however, affect the relative standing of the institution as to numbers. Northwestern occupies its old position and Syracuse has passed Nebraska. Ohio State, Missouri and Leland Stanford occupy the same relative positions as last year, while Indiana has passed Princeton, although the difference in enrolment of the two institutions is quite small. Omitting the summer session registration, the order would be as follows: Harvard, Michigan, Columbia, Minnesota, Cornell, Illinois, Pennsylvania, Yale, California, Northwestern, Wisconsin, Syracuse, Chicago, Nebraska, Ohio State, Missouri, Leland

Stanford, Princeton, Indiana, Virginia and Johns Hopkins. It is to be hoped that none of the universities included in the table is entering into competition with its fellows for mere numbers, and I trust that this article will not be interpreted by the reader as desiring in any way to lay stress upon the factor of numbers as the most important item in the development of a higher institution of learning. Nevertheless, the figures reflect certain important features of the manner of expansion of prominent American universities, and viewed from this standpoint, they are no doubt of value.

Examining the different faculties, we are struck at once by the continued decrease in attendance at the medical schools throughout the country, a loss that can not be explained by increased admission requirements alone. Unquestionably the reasons stated in a previous article must also be taken into consideration.[2] Numerous reports indicate that in France especially the supply of physicians is far in excess of the demand. The only increase of note at any of the medical schools enumerated in the table is at that of the University of Pennsylvania, where the faculty of medicine shows a gain of 33 students, making the Pennsylvania medical school the largest in the list, Illinois being second, Northwestern third and Columbia fourth. One half of the law schools show a gain, whereas the other half have experienced a loss in attendance. The law school of the University of Michigan is by far the largest of those mentioned in the table, Harvard still being second, Minnesota third and Pennsylvania fourth. Columbia and Yale are apparently equal in size, but the Columbia figures do not include 24 college seniors, which would bring its total law registration to 301. The scientific schools continue to increase all along the line. At Princeton the number of scientific students is practically equal to the number of academic students, while only three years ago there were 264 more academic than scientific students. At Yale, too, the number of scientific students is increasing rapidly, and the difference between the number of academic and scientific students has been reduced from 445 to 295 during the past three years. At the same time, it should be pointed out that the increase in the scientific schools is not quite as marked in a number of institutions as it has been in previous years, yet if the present rate of increase should continue, the time will no doubt come when the supply of students equipped for technological work will exceed the legitimate demand. The Massachusetts Institute of Technology shows a falling off in enrolment this year compared with the corresponding date last year. The statement occasionally made, sometimes more in jest than in earnest—especially in connection with the coeducational institutions in the middle west—that the large increase in the number of women students in the academic department is causing men to flock to the scientific schools in these institutions, is no doubt founded upon fact in more than one instance. Cornell still leads in the number of scientific students, Michigan being second, Yale third and Illinois fourth, and Harvard continues to have the largest academic enrolment. Its summer session was also the largest last year (leaving Chicago out of consideration), Columbia's being second, California's third and Indiana's fourth. The Columbia figures are exclusive of the scientific students registered for summer work in surveying, geodesy, etc., away from the university. Columbia, with an enrolment of 804 stu-

[2] Cf. SCIENCE, N. S., Vol. XVIII., No. 467, December 11, 1903, p. 741.

dents in the graduate faculties, easily maintains the lead in this department which it has held for several years, Harvard, Chicago and Yale following in the order given. Northwestern has the largest dental school, with Pennsylvania second, and the former institution possesses the largest divinity school. The greatest number of music students is enrolled at Syracuse, and the Columbia school of pharmacy is more than twice as large as that of its closest numerical competitor, Illinois. The largest veterinary college is at the Ohio State University, and by far the largest school of agriculture is found at the University of Minnesota, the number of agricultural students at the University of Illinois being 100 less than one half the number of those at Minnesota. The gains that have been made by the schools of agriculture all over the country are worthy of especial mention. As far as is known, instructors in summer schools who are not also counted in the regular academic year of 1905–06 are not included under officers. Of these there were no less than 47 in the Harvard summer school, which would bring the Harvard officers' total to 616.

Taking up the different institutions given in the table in alphabetical order, we note that there has been a slight decrease in the enrolment at the *University of California*, a decrease affecting the summer session as well as the regular term. In the academic department there has been a slight gain and in the scientific schools a slight loss. In the undergraduate departments of the university advanced matriculation requirements were put into effect for the first time this fall. The chief of these new requirements was the addition of French and German to the requirements for admission to all of the engineering colleges and the addition of geometrical drawing to the regular requirements of these colleges. This year, also, the university for the first time required that all candidates for teachers' recommendations shall spend at least one half-year in the graduate school (after receiving a baccalaureate degree) before receiving their recommendations as teachers. This latter requirement has resulted in a considerable increase in the number of graduate students (from 194 to 271), and it may also have resulted in some loss in the number of undergraduate students, by reason of the fact that prospective teachers may have gone directly from the high schools to the normal schools for their professional training. The professional schools of law and medicine both show a falling off, which is especially marked in the school of medicine, where the decrease has been one from 106 to 72. A year ago there were 33 first year men in medicine, as against 9 this year, the large falling off in their number being due to the fact that beginning with this year no students were admitted to the medical school who did not possess the equivalent of two full years of regular work in a college or university. Although the requirements for matriculation in the college of agriculture were this year advanced so as to equal the requirements for the other schools of the university, there has been a decided gain in the number of new students, an increase that we shall note in connection with all of the other institutions on the list, with a single exception. The dental school shows a slight loss and the school of pharmacy a small gain. The summer session shows a falling off from 913 to 795. Of the 3,631 students at the University of California, 1,872 are men and 1,759 are women.

The fall enrolment at the *University of Chicago* shows a considerable increase over that of last year, whereas the gain in the summer term of the university is not so marked. The college department shows a

considerable increase in the number of students, both men and women, and there have been gains also in law, medicine, divinity, pedagogy and in the graduate schools. The 168 students mentioned under 'other courses' are enrolled in the course in railway instruction, which was begun during the winter cf 1904–05. Through an oversight, the number of officers of the university was incorrectly stated last year. The total number given this year includes the actual administrative officers and instructors, but no officers engaged merely in extension work or in affiliated institutions. Of the 4,557 students, 2,332 are men and 2,225 are women.

Columbia University shows a slight decrease in enrolment over the previous year, due largely to increased requirements in the professional schools of law, medicine and pharmacy. The academic department shows a considerable gain over the preceding year and reports the largest entering class (157) in its history. This increase may be attributed to several causes, the chief of which is the adoption of a new program of studies, which provides for the degree of B.S. as well as for the degree of A.B. Among the important innovations in the new program the following may be mentioned: Beginning with September, 1905, one half year instead of the whole year is made the unit of credit, the term 'point' signifying the satisfactory completion of work requiring attendance one hour a week for one half year, and the requirement for graduation being 124 points; at least 9 points, exclusive of prescribed work, must be made before graduation under some one department; in any half-year not more than one course in which the student is marked D (poor) may be counted towards a degree; a failure in any prescribed course calls for a repetition of the course; the mark A (excellent) in any two courses entitles the student to one point of extra credit, provided he has not fallen below the mark B (good) in any of the courses pursued by him during the half-year; a candidate for the degree of A.B. or B.S. must fulfil all requirements for the degree within six years from the time of his first matriculation as a freshman, whether at Columbia or elsewhere; every recipient of the degree of A.B. or B.S. must have made at least 84 points in actual college residence, of which no less than 24 points must have been made in Columbia College; when 72 points (including all prescribed work) have been made, a student may—under certain conditions—take the studies of the first year of the schools of applied science, of the college of physicians and surgeons, of the professional course of Teachers College or in the school of fine arts, and receive the degree of A.B. or B.S. upon the satisfactory completion of two years' work in the professional course; when 94 points, including all prescribed work, have been made, and of these not less than 72 in Columbia College, the student may take the studies of the first year of the school of law, and receive the degree of A.B. or B.S. upon the completion of one year's work in this school. A detailed statement of the new program of studies can be found in the article contributed by Professor Calvin Thomas to the *Educational Review,* April, 1905, and to the *Columbia University Quarterly,* June, 1905. It will be seen from the brief summary given above that students graduated from the public high schools of the city in February are now enabled to enter Columbia College at once, instead of waiting until the following September. The new regulations will also permit a student to graduate in three or three and one half years, instead of in four years, which has been the normal time heretofore. The summer session is becoming more and more

an integral portion of the regular course, and the number of students taking advantage of this medium to shorten the length of their course is constantly on the increase. Another factor that unquestionably entered into the growth of the college is the completion of the two dormitories, Hartley and Livingston Halls, which accommodate about 600 men and which will no doubt work a revolution in the life of the undergraduate student body. Five hundred thousand dollars has recently been presented by an anonymous donor for the erection of a building (Hamilton Hall) to be used by the college. This building is to be ready for occupancy in September, 1906, and will no doubt contribute its share to the growth of the college. Barnard College, the undergraduate faculty for women, shows a slight gain over last year. In the scientific schools there has been a small loss, due to the stricter enforcement of requirements for advancement, but this loss has been more than made up by the gain in the school of architecture, where there has been a considerable increase on account of the introduction of the *atelier* system and of a new course leading to a certificate in architecture instead of to the B.S. degree. All three classes in the law school are composed for the first time of holders of baccalaureate degrees (leaving college seniors out of consideration), and the result is that there has been a considerable falling off in the attendance. The enrolment in the first year class, counting college seniors, is 94. The school of medicine also shows a large decrease, due to the increased requirements that first became operative two years ago. The new requirements did not affect this year's graduating class, so that the attendance next year promises to be even smaller than it is this year. The entering class consists of 92 men, counting the college seniors. The college seniors are not included in the figures for law and medicine given in the table. In the school of pharmacy there has been a loss of 82. Last year the attendance in this faculty was unusually large, on account of the desire to register as a student of pharmacy before the new statute increasing the requirements for admission to schools of pharmacy became operative. The increased requirements went into effect this fall, with the result that the entering class is considerably smaller than it was last year. The graduate schools show a growth from 709 to 804, and Teachers College has experienced a remarkable increase, namely, from 627 to 792. The summer session in 1905 was larger than the preceding one, but the increase was more than offset by a greater gain in the number of summer session students who returned for work in the fall, there being 280 this year as against 184 last year, thus emphasizing the statement made before, that the summer session is being regarded more and more as an integral portion of the regular course of study.

At *Cornell University* there has been a slight gain in the academic department and a considerable increase in the scientific schools. The law school has remained stationary, the medical school and the veterinary school show a decrease, while the graduate department and the school of agriculture show a gain, which is especially noticeable in the case of the latter faculty. The enrolment in the short winter course in agriculture has increased from 135 to 199. Of the 1,499 students enrolled in the scientific schools, 1,082 are registered in the department of mechanical engineering (Sibley College) and 417 in the department of civil engineering. The summer session shows a falling off compared with the previous year, and here, as at Columbia, there has been an increase in the number of summer

session students returning for work in the fall. Several new regulations covering students' fees have recently been adopted. For the first time a matriculation fee of $5 was required of all new students this fall, and the graduation fee has been increased from $5 to $10 and the fee for advanced degrees from $10 to $20. The tuition fees in all courses in the colleges of mechanical and civil engineering have been increased from $125 to $150 per annum. The entrance requirements in engineering have been raised so as to include advanced work in both modern languages, or their equivalent, and this may have contributed to the fact that the departments in question do not show as large gains as they did last year. The number of women students in the university shows an increase for the first time in several years, and this increase probably explains in some measure the gain in attendance in the academic department, in which nearly all of the women students are enrolled.

The total attendance at *Harvard University* shows a decrease of 109, to which the summer session did not contribute. In the college department there has been a loss of 107 men, while Radcliffe College shows a slight increase. The scientific schools, as well as the professional schools of law, medicine, dentistry and divinity, show a falling off in enrolment, while the graduate schools and the department of agriculture show slight gains. The medical school of the university has again raised its standard for entrance by requiring a knowledge of organic chemistry. The full requirements now call for a certificate that the student has passed in one year's full work in organic chemistry, a certificate that he has passed in qualitative analysis, and a college degree. In spite of this fact, there is an increase of ten in the entering class, the first upward step since the requirement of a degree for admission. At Harvard, as at Columbia, the number of high school graduates in the academic department seems to be larger than ever and there is an accompanying decrease in the number of graduates of private preparatory schools. Of the total number of students registered at Harvard University, 4,382 are men and 901 are women.

At the *University of Illinois* there has been a considerable increase in the grand total, but the increase aside from the summer session is also quite marked. The largest growth is shown by the scientific schools and the law school; the number of men in the academic department has remained stationary, whereas there has been an increase of 51 in the number of women in the same department. The enrolment in the school of medicine has decreased from 629 to 540, thus reflecting the falling off in the number of medical students all over the country, to which attention has frequently been called by the writer. The graduate schools, the school of pharmacy and the school of agriculture show slight gains, whereas there has been a falling off in dentistry and music. The students mentioned under 'other courses' are enrolled in the library school, which offers a five-year course leading to the degree of B.L.S. Of the 3,635 students registered at the University of Illinois, 2,898 are men and 737 are women.

The enrolment in the *University of Indiana* shows an increase in the fall registration as well as in the summer session. There is a total enrolment of 1,377 students, of which 862 are men and 515 are women.

At *Johns Hopkins University* there has been a decrease in enrolment of about 7 per cent., for which no definite reason can be assigned. The academic department and the faculty of medicine have remained

stationary, and the falling off has taken place in the graduate schools. The 47 students under 'other courses' are enrolled in medical courses for physicians, and here also there is a decrease over the previous year. Of the 688 students at Johns Hopkins, 658 are men and 30 are women.

The total registration at *Leland Stanford University* shows a decided increase, which is found primarily in the academic department. The graduate schools show a loss of 21. The figure given for the law school last year was 187, but as a matter of fact the law registration this year is larger than it was in 1904. Last year the total number of law majors was given, whereas this year only those students are included who are actually taking law work. The number of law majors this year is 270. The total enrolment at Leland Stanford University is 1,606, of which 1,105 are men and 501 are women.

Statistics of the registration at the *University of Michigan* as of October 24, published in the November issue of the *Michigan Alumnus,* show that there has been an absolute gain of 409 students over the number matriculated at the corresponding date last year. This gain of 13 per cent. is indeed a remarkable one, and the increase at this university has been larger than at any of the other institutions in the list. By far the greatest increase occurred in the literary and engineering departments, and the medical school is the only one that shows a decrease, which may be ascribed to increased requirements, as well as to the fact that the number of students taking the six-year combined literary-medical course is increasing each year. The 82 students under 'other courses' are enrolled in the homeopathic medical school. The so-called deferred degree or combined course plan, which was instituted at Columbia University, is gaining in favor every day, and it seems to solve better than any other the problem of shortening the combined college and professional course, giving, as it does, academic recognition to the collegiate side of the combined course and at the same time maintaining the traditional college course for those students who do not intend to enter a professional school. The enrolment in the Michigan summer session shows a slight gain over that of the preceding year. Of the 4,621 students, 3,794 are men and 827 are women.

The *University of Minnesota* shows a gain over last year. The number of men in the college has remained stationary, whereas the number of women has been increased by 68. The scientific schools show a slight increase, but the professional schools of law and medicine both show a decided falling off in attendance. The graduate schools have lost a few students, while agriculture, dentistry and pharmacy show gains, which are especially noticeable in the former two schools. The summer session has remained stationary. The 14 students under 'other courses' are enrolled in the homeopathic medical college. The total enrolment is 3,940, of which 2,682 are men and 1,258 are women.

The attendance at the *University of Missouri* has increased, the total gain in the fall registration, that is, exclusive of the summer session, amounting to 89. In the academic department there has been an increase in both men and women. The scientific schools have also gained, but the professional faculties of law and medicine show a falling off. The graduate schools and the school of pedagogy show an increase. The first item of double registration is unusually large, inasmuch as many students are taking the six-year combined academic and professional courses, and are therefore registered in two schools. While the figures show an increase in most of the

departments and in the total registration, it should be noticed that a threatened typhoid-fever epidemic in Columbia at the beginning of the regular session caused a number of students to transfer to other institutions. Of the total number of students in the University of Missouri, 1,388 are men and 499 are women.

Inasmuch as the figures given last year for the *University of Nebraska* were those of the academic year 1903–4 and not those for the beginning of the academic year 1904–5, no accurate comparison can be made. The enrolment given in the table for 1902, 1903 and 1904 represents the final figures for the close of the respective academic years, and the total of 2,635 for November 1, 1905, will no doubt be increased to approximately 2,800 by the close of the year, thus showing a slight gain in the total registration over last year. The 200 students mentioned under 'other courses' will probably be enrolled in the short course in agriculture, their number being only estimated. The increase in registration has occurred in the scientific schools and in the departments of law and agriculture. Medicine shows a decided falling off. Of the 2,435 students enrolled, (*i. e.*, excluding the prospective enrolment in the short course in agriculture), 1,275 are men and 1,160 are women.

Northwestern University shows a slight decrease over last year. There has been a considerable gain in the academic department and in the theological school, and smaller gains in the law school and the school of music. No particular reason can be ascribed to the decrease in the medical school; it seems merely to reflect the decrease in the number of medical students that has been noticed for several years throughout the country. The marked decrease in the dental school is due to the graduation of an unusually large class in June, a class which had been carried for three years and which was abnormally large, because of the fear that the length of the course might be increased to four years. Three years ago the entering class in the dental school was two or three times as large as might naturally have been expected, and the following class was proportionately small. The registration of the first-year men in the school this year has been considerably larger than was anticipated. The decrease in the school of pharmacy is apparently due to an advance in the admission requirements by the addition of one year of high school credit. Northwestern University has a total registration of 2,791 students, of which 1,998 are men and 793 are women.

Ohio State University shows a decided gain over last year, in which the scientific schools have a considerable share, although the academic department also shows an increase in both men and women. The law school, the graduate schools and the school of forestry show a decrease, whereas agriculture, pharmacy and the veterinary school show an increase. The enrolment at the summer session has almost tripled. The total registration at the university is 2,057, of which 1,645 are men and 412 are women.

The increase in the enrolment at the *University of Pennsylvania* is quite striking; indeed, the increase in the total number of students is the largest in the history of the institution. Every department except the dental school shows a gain over last year, and notwithstanding the fact that the fees in all departments have been slightly raised, all the entering classes show a considerable increase, even in the dental school, where $60 per year has been added to the tuition. An innovation in the payment of tuition fees in the college has been announced by the university au-

thorities. The tuition in the academic department has been fixed at $150 a year, whereas during the past few years every student was required to pay $10 for every unit of work taken by him, sixty units being necessary for the degree. The 621 students mentioned under 'other courses' are distributed as follows: 303 are enrolled in the evening school of accounts and finance, 278 in the school of finance and commerce and 40 in biology. The figures for last year included 155 students under the heading Teachers College. This year there are 226 students enrolled in special Saturday courses for teachers, but they have been excluded from the table, inasmuch as similar students are not counted in the Columbia and Harvard figures.

Princeton University has experienced a slight decrease in enrolment, although the freshman class shows a gain. The academic department has decreased from 665 to 629, whereas the scientific schools have lost only 4 students. There has been a slight gain in the graduate schools.

Syracuse University continues to make the consistent gains that it has shown during the past few years and these gains are visible all along the line, except in the faculty of medicine.

The total enrolment at the *University of Virginia* has remained stationary to all intents and purposes, although there have been changes in different faculties. The professional faculties of law and medicine both show a falling off, which is especially noticeable in the case of medicine.

The *University of Wisconsin* apparently shows a decrease in the total registration, whereas in reality there has been a slight gain, inasmuch as the dairy students and short-course students in agriculture are not included in this year's figures. The large number under the first item of double registration is due to the fact that the classification at the University of Wisconsin is based upon a somewhat different plan from that followed in the accompanying table. The school of pharmacy and the pedagogical course are included in and are a part of the college of letters and science, and the same is true of the students in the graduate school; where the latter are taking work in engineering or in agriculture they are classified as graduate students in these courses and are included in the total attendance of the college, so that the total in the college of arts includes the graduate students in that college, as well as the students in pharmacy and pedagogy. The total number given in the graduate school includes graduate students taking work in the college of letters and science, the college of engineering and the college of agriculture. There has been a slight decrease in attendance in the college of engineering and the school of law, a decrease that is accounted for by advanced entrance requirements that became operative in these colleges this fall. For admission to the school of law the candidate is now required to have had at least one year's attendance in college in addition to the regular entrance requirements. In engineering increased requirements in mathematics have gone into effect. The increase in the attendance at the summer session is worthy of note, for there were 136 more students in 1905 than in 1904. Of the total students enrolled, 2,170 are men and 913 are women.

The total registration at *Yale University* shows a decided increase over last year, which may be attributed in some measure to the fact that the first summer session held by the university was opened in July, 1905. It has been impossible to obtain the correct figures under the second item of double registration and it was necessary to make an estimate, which no doubt comes

near the truth. All of the departments, with the exception of medicine, divinity and forestry show an increase. The enrolment in the Sheffield Scientific School has increased from 774 to 1,028, although it should be pointed out that graduate students in science were not included in the Sheffield figures last year, whereas they have been included in this year's table. The final registration is likely to carry the number of freshmen in the scientific school beyond that of the academic freshman class, which is an epoch in the history of the departments. The scientific freshman class is so large that it has had to be divided into twelve divisions instead of ten, as last year. In six years the size of the entering class in the scientific school has risen from 199 to about 400, an increase of over 100 per cent.

The general development of higher education in the United States as reflected in the accompanying tabulation is one that may well give rise to gratification, and it is hoped that the prominent exponents of higher education in this country will vie with one another in constantly increasing the quality of their work and the value of their equipment, instead of laying undue stress on any figures that do not reflect a corresponding development in academic standards and ideals.

Rudolf Tombo, Jr.,
Registrar.

Columbia University.

THE ANNUAL REPORT OF THE SECRETARY OF AGRICULTURE, 1905.

The secretary says that it is in the highest degree gratifying to present evidence of the unprecedented prosperity which has in recent years rewarded the diligence of the farmer and the efforts of his department. A year of unequaled prosperity has been added to the most remarkable series of similar years that has come to the farmers of this country. Farm crops have never before been harvested at such a high general level of production and value. Corn has reached its highest production, over 2,700,000,000 bushels, of a total estimated value of $1,216,000,000. Hay comes second, with a value of $605,000,000. Cotton is expected to yield $575,000,000. The short wheat crop of last year is followed by one of 684,000,000 bushels, and its value, $525,000,000, overtops the highest value ever before reached. While only one crop, corn, reached its highest production this year, four crops—corn, hay, wheat and rice—reached their highest value.

No crop but corn produces the income that the dairy cow does. The estimate of the value of dairy products for 1905 reaches $665,000,000. The farmer's hen competes for precedence with wheat, poultry products aggregating half a billion dollars in value.

The wealth production on farms in 1905 has reached the highest amount ever attained by the farmer of this or any other country, 'a stupendous aggregate of results of brain and muscle and machine,' amounting in value to $6,415,000,000, an excess over last year of $256,000,000. The wealth produced on farms in 1905 exceeds that of 1904 by 4 per cent., that of 1903 by 8 per cent., and that shown by the census figures for 1899 by 36 per cent. Should there be no relapse from his present position as a wealth producer, three years hence the farmer will find that the farming element, about 35 per cent. of the population, has produced an amount of wealth within ten years equal to one-half of the entire national wealth produced in three centuries.

The value of horses and mules on farms exceeded last winter $1,452,000,000. Milch cows are advancing in numbers and are worth $482,000,000. The value of all other cattle is estimated at $662,000,000. Sheep are declining in number and total

value, while swine maintain their previous position, and are valued at over $283,000,000. In the aggregate, the value of farm animals of all sorts has increased over that given in the census of 1900 by 9 per cent.

During the last fiscal year, exported domestic farm products were valued at $827,000,000. This is below the annual average for the five years preceding, and the relative position of farm products in domestic exports is a declining one on account of the gain in exports of manufactures. Nevertheless, during the last sixteen years the domestic exports of farm products have amounted to $12,000,000,000, or $1,000,000,000 more than enough to buy all the railroads of the country at their commercial value, and this with the mere surplus for which there was no demand at home. During these sixteen years the farmer has secured a balance of $5,635,000,000 to himself, out of which he has offset an adverse balance of $543,000,000 in the foreign trade in nonagricultural products, turning over to the nation, from his account with other nations, $5,092,000,000. The exports of forest products were $63,000,000.

Computations based upon census information show that farm products constitute 56.4 per cent. of the total products of the country, and 86.8 per cent. of the total materials of industries utilizing agricultural products as materials. During the last census year farm products employed in manufactures were valued at $2,679,000,000. These industries employed 2,154,000 persons, and had a capital of $4,132,000,000.

One of the most notable outgrowths of savings by farmers is the great multiplication of small national banks in recent years. As many as 1,754 banks, each with a capital of less than $50,000, were organized from March, 1900, to October, 1905. These were distributed mostly throughout the south and the north central states, in rural regions. In the south 633 of these banks were organized, and in the north central states 792. The capital of these banks has come from the farmers. The increase of bank deposits in agricultural states is most extraordinary. The increase during the year which ended June 30, 1905, in Iowa and South Dakota was 14.9 per cent.; in Nebraska, 13.5 per cent.; in Kansas, 9.7 per cent. and in North Dakota 25 per cent. During the same time bank deposits in Massachusetts increased 9.1 per cent. But still more remarkable is the bank statement for the south central states. Throughout the whole area of that division the increase was 22.8 per cent., while the general average increase for the United States was but 13.5 per cent. For the first time in the financial history of the South, deposits in the banks of that region now exceed $1,000,000,000. These remarkable increases in bank deposits in agricultural States and the increase in the number of small country banks are directly and indirectly because of the profits that have come to the farmers.

The department this year undertook, and has just completed, an investigation of the changes in the value per acre of medium farms since the census of 1900. Inquiries were addressed to 45,000 correspondents distributed throughout every agricultural neighborhood in the United States, and returns from these correspondents warrant the following statements:

During the past five years the value of medium farms in this country has increased 33.5 per cent. as compared with an increase of 25 per cent. for the ten years preceding. The increase in the south central group is 40.8 per cent.; in the western group, 40.2 per cent.; in the South Atlantic group, 36 per cent.; in the north central group, 35.3 per cent., and in the North Atlantic group, 13.5 per cent.

Figured in dollars of gain per acre, the increases during the five years past of medium farms were in the north central division $11.25; in the western division $5.36; in the North Atlantic $5.26; in the South Atlantic division $4.93; and in the south central division $4.66. The average increase for the United States was $7.31. The returns showed that farms of less intensive culture and crop have increased in value less than the farms having more valuable crops and receiving high culture. Everywhere is revealed a more intelligent agriculture. Farmers are improving their cultural methods and changing from less to more profitable crops. Other causes for higher values are better buildings, better fences, tile draining, new facilities for transportation, more railroads, and better wagon roads.

The cotton farms have increased in value $460,000,000, so that it might be said that during the past five years the cotton plantations have had six crops, one of them a permanent investment promising to pay a good return year by year. Hay and grain farms show an increase of $2,000,000,000; livestock farms a still larger gain; dairy farms $369,000,000; tobacco farms, $57,000,000; rice farms $3,300,000; fruit farms $97,000,000 and vegetable farms $113,000,000. Every sunset during the past five years has registered an increase of $3,400,000 in the value of the farms of this country. Every month has piled value upon value until it has reached $102,000,000; that portion of the national debt bearing interest is equaled by the increased value of farms in nine months, and this increase for a little over a year balances the entire interest-bearing and non-interest-bearing debt of the United States.

The secretary thus summarizes the economic position of farmers:

If the farmers' economic position in the United States is to be condensed to a short paragraph, it may be said that their farms produced this year wealth valued at $6,415,000,000; that farm products are yearly exported with a port value of $875,000,000; that farmers have reversed an adverse international balance of trade, and have been building up one favorable to this country by sending to foreign nations a surplus which in sixteen years has aggregated $12,000,000,000, leaving an apparent net balance of trade during that time amounting to $5,092,000,000 after an adverse balance against manufactures and other products not agricultural, amounting to $543,000,000 has been offset. The manufacturing industries that depend upon farm products for raw materials employed 2,154,000 persons in 1900 and used a capital of $4,132,000,000. Within a decade farmers have become prominent as bankers and as money lenders throughout large areas; and during the past five years prosperous conditions and the better-directed efforts of the farmers themselves have increased the value of their farms 33.5 per cent., or an amount approximately equal to $6,133,000,000.

Following his introduction he refers to the fact that this is the first annual report of his third term as secretary, and on this ground he presents rather a review of the work of the department during the eight years just elapsed than the ordinary synopsis of the operations of the year.

He presents the results accomplished by the Weather Bureau for the benefit of the farmers, mariners and manufacturers, and points out that with all the development of this work the average per annum increase in the cost of the service for the past ten years is but 4.41 per cent. He emphasizes the necessity of scientific research with the view to acquiring a greater knowledge of meteorological science. With this view he established three years ago a station at Mount Weather, Va., devoted to meteorological research. He proposes that the Weather Bureau shall hereafter attain as eminent a position in the work of scientific research as it has heretofore admittedly held in practical meteorology.

Of the Bureau of Animal Industry he says that the work of fighting contagious

diseases of animals has been unremittingly carried on. The report refers in detail to the principal diseases which have been made the subject of study, and concludes that in every case the efforts of the bureau have been attended with a more satisfactory control or complete eradication. He commends highly the skill and energy which characterized the suppression of foot-and-mouth disease in the New England States in 1902 and 1903. He dwells at some length on the subject of tuberculosis and the danger of its being communicated from animals to man. Of the cattle and meat inspection he says its importance is shown by the fact that upon the government certification as to the healthfulness of animals and animal products the country depends for its access with its products to foreign markets. He deprecates the possibility of abandoning any part of this work, a contingency, nevertheless, which he foresees to be unavoidable unless adequate appropriations are promptly provided for this work.

To the Dairy Division of the Bureau of Animal Industry was assigned under the law of May 9, 1902, the inspection of materials, factories and processes employed in the manufacture of renovated butter. The results have been very satisfactory. This division has accumulated and published in the past few years a large amount of valuable information of value to the dairymen and those interested in dairy products.

The Bureau of Plant Industry is organized into eleven offices and employs over 500 persons, about 60 per cent. of whom are engaged in distinctly scientific work. The review of its investigations and treatment of plant disease shows that all important diseases have been studied with results which in many cases have enabled farmers and fruit growers to greatly diminish their losses from this cause.

In its systematic work in securing new plants and seeds from foreign countries the Bureau of Plant Industry has been highly successful. Success has also attended its work in cotton breeding, undertaken with the view to obtaining new sorts combining improved length of staple with productiveness. The secretary records the production of a new citrus fruit, the citrange, several varieties of which—the Rusk, the Willets, the Morton—have been developed. Another interesting product is the new tangelo, a hybrid of the pomelo and the tangerine.

Of the work on nitrogen-fixing bacteria the secretary says that there is yet much to be done in determining the conditions under which the use of the tubercle-forming bacteria will give the best results, but that the Bureau of Plant Industry has developed a successful method of growing and distributing them and increasing their nitrogen-fixing power.

Many intelligent boards of health and water engineers are recognizing the value of the method recommended for the destruction of algal and bacterial contaminations of water supplies.

Much has been done also in perfecting the methods for testing seeds. The farmers' attention has been called to the adulteration of field seed, and they have been invited to submit samples for testing.

The secretary records the practical establishment of Durum wheat, of which several million bushels have been exported this year, and reports highly satisfactory results with new varieties of oats and barley, and the extension of the winter grain area. The last few years have witnessed a great progress in rice growing and in beet-sugar production. Valuable information has been made available in reference to the shipment and transportation of fruit. At the Summerville tea farm 9,000 pounds of tea was the product for the past season,

and a promising tea farm has been established in Texas.

Very considerable importance is recorded in the manner of seed distribution. A special feature has been the encouragement of school-garden work thereby.

The work of the forest service has been greatly developed. Of the eleven persons employed July 1, 1898, only two were professional foresters. To-day the forest service employs 153 professional foresters out of a total force of over 800 persons. An important achievement of this service during the past few years has been to enlist the sympathy and cooperation of lumbermen and forest owners, and the secretary urges that the work of education continue until public opinion will not tolerate heedless waste or injudicious loss. In the saving of waste the service has added vastly more to the national wealth than its total expenditures during its entire history. The control of the forest reserves, embracing property worth in cash at least $250,000,000, has been transferred to the forest service. This property is administered at a cost of less than one-third of 1 per cent. of its value, which increases at the rate of 10 per cent. per annum. The service continues to afford important aid to private forest owners.

The Bureau of Chemistry has conducted important investigations relating to our cereal products and prepared meats. The latter included a systematic examination of canned goods. Its practical experiments have developed the fact that, without exception, the addition of the ordinary preservatives to foods is prejudicial to health. The secretary argues the need of protecting the public from these evil effects by legislation. The Bureau of Chemistry inspects all food products intended for export where the exporters desire such inspection, which enables them to send foods to foreign countries with a certificate of inspection which, as a rule, is accepted. Of imported foods inspected 712 out of 3,576 invoices were of a character forbidden by law. Elaborate studies have been made of insecticides, in cooperation with the Bureau of Entomology, and also of materials furnished under contract to the United States government. In this work the Bureau of Chemistry has cooperated considerably with other departments of the government.

In spite of the activity of the survey force of the Bureau of Soils, there are on file at the present time requests for mapping 215 counties in 40 states and territories. The bureau has made a special study in regard to the alkali soils and into the problem of soil fertility. In this work the problems encountered in the field depend for their final solution on the work in the laboratory. The purpose of the soil survey is to indicate the most economical method of securing the best results in handling the various soils and in the production of food products from them. The surveys already made aggregate 63,000,000 acres in 44 states and territories. The soils adapted to special crops such as the grape, the apple, citrus fruits, the sugar-beet, alfalfa, rice, corn, cotton, etc., have all been made subjects of special study based on the field surveys. The demands for reports of the surveys are numerous and varied, all classes seeming to be interested in them. The investigations of this bureau into the question of soil fertility and manurial requirements have attracted general attention and much comment. As the bureau's methods of investigation are becoming more thoroughly understood they are being gradually adopted for scientific work by investigators outside of the department. Much practical work has been done in the reclamation of alkali lands. Important work in regard to tobacco has been continued in Texas, Ohio, Virginia and Connecticut. The secretary recommends in-

vestigations of the same kind in the tobacco districts of several other states.

In discussing the work of the Bureau of Entomology considerable space is devoted to the Mexican cotton boll weevil, in the work against which this bureau has had the active cooperation of the Bureau of Plant Industry. It is also cooperating with the Louisiana Crop Pest Commission and the Texas Experiment Station. The subject of dissemination of the weevil through cotton gins has been very carefully investigated, and important results have been obtained, resulting in recommendations to the ginners calculated to greatly reduce this danger.

Of recent years important work has been done by the Bureau of Entomology in the introduction of the fig fertilizing insect of South Europe, the introduction of a parasite of the black scale so injurious to citrus and olive crops in California from South Africa, and the introduction with success in the southern states of a parasite of the San Jose scale from China. Useful insects are also sent abroad at the request of foreign departments of agriculture.

Fruit growers in California and other states testify that their operations have been rendered much more profitable through the information derived from the investigations of insects injurious to fruit. The insects damaging forests, injuring stored fruits, carrying diseases, affecting live stock, and injuring field crops have all been the subject of study by the entomologists of the department.

In 1902 the Bureau of Entomology undertook once more a systematic effort to introduce the culture of the domestic silkworm into the United States. Guaranteed eggs were purchased in Italy, skilled reelers were brought over from France, and mulberry trees were distributed to persons desiring to experiment.

Much emphasis is laid upon and considerable information is given as to the saving from insect losses resulting from the work of the Bureau of Entomology. The actual loss to agriculture through injurious insects is almost beyond computation.

The work of the Bureau of Biological Survey includes the determination of the boundaries of the natural life zones of the United States and the corresponding crop zones. The chief purpose is to ascertain the boundaries of natural life zones with a view to aiding the farmer in selecting crops best adapted to his locality and in avoiding crops unsuited to it.

One section of the Biological Survey is engaged in the study of birds and their various relations to man, especially to determine whether birds damage crops, whether they protect insects either injurious or beneficial, and to what extent they feed upon weed seeds. Thousands of birds' stomachs are examined in gathering facts on this subject.

Other duties of the Biological Survey are the supervision of game protection and introduction assigned to the Department by Congress. Through cooperation with the Department of Justice and with game officials throughout the United States 166 violations of the Lacey Act were investigated and 49 convictions have resulted. Railroad and express companies have lent cordial cooperation in securing a more rigid observance of the game laws.

In discussing the work of the Division of Publications the secretary points out that the terms of the law requiring the department to diffuse information of value to agriculture are mandatory, and the most economical and available means of diffusion is through publication. He maintains that this work has been conducted with due regard to economy, and that every precaution has been taken to lessen the waste inevitably attendant upon any system of gratuitous distribution. Of the more than

twelve million copies of all publications distributed by the department during the past year nearly 45 per cent. were distributed through senators and representatives in congress, over which distribution, of course, the secretary has no control. He notes with approval a growing demand for the department publications from institutions of learning and other agencies interested in agricultural education.

Referring to the work of the Bureau of Statistics, the secretary says that the development of organizations to fix prices, and in some cases to force temporary changes giving unnatural advantages to price manipulators, has led to the need for a strong and impartial agency to make comprehensive reports of actual facts relating to prospective crops and yields, that all concerned may know how to buy and sell. He describes the various processes of crop reporting, the conditions under which, and the methods by which the reports are made.

The secretary states that as the result of a gross breach of trust on the part of one of the officials, an entirely new method of handling these reports is being devised, which he believes makes it practically impossible for such another breach of confidence to occur. He reports the prompt dismissal of the culpable official and the transfer of the whole matter to the Department of Justice, with a view to the prosecution of the guilty party. He expresses regret that while the department handled the case of its own official with vigor and promptness, no corresponding action has so far reached the traders' end of the line.

Where gamblers interested neither in production nor in consumption disturb values to the injury of both and make loud outcry when creatures of their kind bribe officials to betray confidence for the love of money, the responsibility for this leak is shared by every one who to get money without work gambles in farm products. When this form of industry ceases, he adds, these parasites who tempt department officials will have to work for their bread.

He reports the assignment of Assistant Secretary Hays to take charge of the work of the Bureau of Statistics for the present.

Of the Division of Foreign Markets, the secretary says one of its useful lines of investigation in behalf of exporters has been an examination of conditions found in countries which have a surplus in certain agricultural products which meet those of this country in common markets. Another useful undertaking has been to ascertain in detail the quantities and values of the agricultural imports of countries receiving a large share of such imports from the United States. In regard to the possibility of a foreign cotton competition, the inquiries of the department do not reveal that it has any reasonable immediate prospects, and he believes that if such competition is to arise, it will be as the result of years of effort and development. Most of the countries wherein a new production is admitted, moreover, produce a non-competing variety like the Egyptian.

Of the library the secretary reports the present quarters to be inadequate for housing its collection of 87,000 books and pamphlets. In addition to space for this valuable possession of the department, the protection from fire is an urgent need. Such protection he anticipates will soon be provided by the new building. The library is found available for information to be given in response to inquiries from all parts of the country, and much valuable material is added to its files through the foreign exchange system.

The work of the Office of Public Roads is primarily educational in character. Its province is to detail experts to give information and advice. In many communities it is found advisable to supplement advice by practical demonstration of effective road building. The total number of ex-

perimental and object-lesson roads built under the direction of this office since its organization is 96, with a total length of about 39 miles. These roads were built in 38 states. The secretary proposes to utilize the services of the greatly increasing corps of highway engineers and experts of the office wherever practicable in the construction and maintenance of roads in the forest reserves. In order to secure engineers with the necessary technical training and to supplement such training by special work for highway engineering, graduates of reputable engineering colleges are appointed as civil engineer students in the Office of Public Roads. The work of such students is of great assistance to the office, besides being of practical value to the public. The secretary believes that highway engineering should receive greater attention at the present time in the colleges. A Division of Tests has been organized in the office, primarily to test road materials, but the equipment necessary for this purpose has been also available for testing other materials of construction, such as steel wire for fences, concrete posts, etc.

The work of the Office of Experiment Stations has greatly increased during the past eight years. Through this office the secretary exercises a certain supervision of the federal funds granted to the experiment stations. He says that the stations have been not only a benefit in making the department's work more effective, but that they have by their own investigations raised American agriculture to a higher plane. He expresses the hope that congress will recognize the need of providing the stations with means to meet the demands made upon them, and states that there is no direction in which public moneys can be appropriated that will bring more certain and lasting returns than in helping the state experiment stations.

To diffuse among farmers the results obtained by stations, the department undertook the publication of a series of popular resumes of practical features of the station work. Over thirty numbers have been issued as a part of the Farmers' Bulletin series. The secretary reports great activity in the development of agricultural education, and through the Office of Experiment Stations the department has taken a leading part in this work. The permanent success of agriculture, he argues, depends upon the technical intelligence and knowledge of the farmers. In this line of work the farmers' institutes, established under the authority of the various states and territories, furnish the most useful agencies. Practical benefit to the people interested is reported as the result of the establishment of experiment stations under the direct control of the department in Alaska, Hawaii and Porto Rico.

Nutrition investigations are conducted by this office and during the past eight years some 200 dietary studies have been made, and not far from 800 experiments in which the digestibility of different foods was determined with healthy men under normal conditions. It has been found as the result of some of these studies that white bread furnished the body with more protein and energy, pound for pound, than whole wheat or graham flour for the same amount of grain, any deficiency in the composition of the white flour being more than offset by its more thorough digestibility.

The irrigation and drainage investigations of the department have resulted in the systematic study of the agricultural and legal features of irrigation. Measurements of the quantity of water used in ordinary practise have been followed by more careful experiments to determine the frequency of irrigation and the amount of water to be applied to get the best results. The studies of irrigation laws have included the collection of facts showing the

character and amount of water rights. Experiments are being made to determine how far drainage can be made to protect hillsides from destructive effects of erosion. In the whole country there are 100 million acres of swamp and poor lands, which can be reclaimed only through drainage.

Of the new buildings the secretary says that the structures now being built will cost about one and one half million dollars, and should be completed in two years, by which time it is hoped that further appropriations will be available to continue the building work inaugurated.

Speaking of the growth of the department, the secretary reports the number of persons on the rolls July 1, 1905, to be 5,446. Of these, 2,326 are rated as scientists and scientific assistants. This shows an increase since July 1, 1897, of 3,003 persons on the rolls of the department, of which the increase in the number of the scientific staff in the same period was 1,401.

In conclusion, the secretary says it has been a grateful task to present to the president and thus to the American people a pen picture of the American farmer as he is to-day, to make clear the position of the farming industry, its wonderful productiveness, and its large contribution to the general prosperity of the country. He has also pointed out some of the more important work illustrative of the methods by which the department seeks to benefit the farmer. Its work is two-fold. It seeks to add to the sum of intelligence in the man and to increase the productive capacity of the acre. In this work the department has the hearty cooperation of the agricultural colleges and experiment stations, all working with the department to the same great end. The gratifying evidences of well-being in the farming community, the extraordinary progress made, and the enlarged recognition of the true position of the farming industry in the economic life of the country are mainly the result of this continued and combined effort on the part of these agencies to add to the sum of the farmer's knowledge, and must be regarded as the triumph of intelligence in the application of scientific knowledge to the tillage of the soil. This he maintains is so true that it would be superfluous to urge the generous maintenance of the department in its grand work.

Great as has been the work undertaken and accomplished, gratifying as have been the results as shown in the first few pages of this report, be it remembered that we are still at the threshold of agricultural development and that the educational work which has led to such grand results has only been extended as yet to a portion of our agricultural population.

SCIENTIFIC BOOKS.

NEWCOMB'S REMINISCENCES.[1]

When a man lays down the arduous pen of the mathematician, which he has used throughout a long life to the admiration of the world, and takes up in leisurely fashion that of the autobiographer, he is tolerably sure of our respectful attention. But Professor Newcomb has won from us far more than this: he has earned our lasting gratitude by the production of a book which is delightful to read and which makes several contributions to the history of astronomy. Of the eminently readable character of the book it is easy to assure oneself by opening it at random, for on almost every page there is an anecdote or the equivalent, rendered accessible to the lay reader, where necessary, by admirable exposition of astronomical terms and touched infallibly with a genial humor. The variety of topic is specially noteworthy; the author is as much at home in explaining why the United States results from the Transits of Venus were not reduced (because after spending $375,000 on the observations it was found to be impossible to secure $5,000 for the computations—see p. 178) as he is in vividly sketching Mr. Gladstone thus:

[1] 'The Reminiscences of an Astronomer,' by Simon Newcomb. Houghton, Mifflin & Co., 1903.

It could not be said that he had either the dry humor of Mr. Evarts or the wit of Mr. Depew; but these qualities were well replaced by the vivacity of his manner and the intellectuality of his face. He looked as if he had something interesting he wanted to tell you; and he proceeded to tell it in a very felicitous way as regarded both manner and language, but without anything that savored of eloquence (p. 276).

Or we may turn to another page and find a note, brief but vigorous, on the visit of Dom Pedro of Brazil 'the only emperor who had ever set foot on our shores.' (May we Englishmen hope that the Emperor of India will be the second?) On another page is a good story of Argelander and Gould.

When with him [Argelander] as a student, Gould was beardless, but had a good head of hair. Returning some years later, he had became bald, but had made up for it by having a full, long beard. He entered Argelander's study unannounced. At first the astronomer did not recognize him.

"Do you not know me, Herr Professor?" The astronomer looked more closely. "Mein Gott! It is Gould mit his hair struck through!"

[By the way, there is a little misprint in the German.]

But, as above remarked, there are many real pieces of astronomical history, related with the same charm of simple directness. We may surely rank as such the incidents connected with the discovery of 'Lane's Law,' for instance. Newcomb was walking home after a scientific club meeting with Mr. Taylor and—

A little man whose name he did not even know, as there was nothing but his oddity to excite any interest in him, and on the way was explaining a theory to his companions in that *ex cathedra* style which one is apt to assume in setting forth a new idea to people who know little or nothing of the subject. My talk was mainly designed for Mr. Taylor because I did not suppose the little man would take any interest in it. I was, therefore, much astonished when, at a certain point, he challenged, in quite a decisive tone, the correctness of one of my propositions, * * * informing us that he had investigated the whole subject and found so and so—different from what I had been laying down. * * * Naturally I cultivated the acquaintance of such a man. His name was J. Homer Lane (p. 247).

And again we may put in this category the generous record of the fact that the genius of the Clarks as makers of object-glasses was first recognized in England; the agent being the Rev. W. R. Dawes, who saw, from a letter sent him by Mr. Clark,

describing a number of objects which he had seen with telescopes of his own make, that the instruments must be of great excellence, and ordered one or more of them. "Not until then were the abilities of the American maker recognized in his own country" (p. 149).

Or again we may reckon as a historical incident the vindication, by Professor Newcomb himself, of Father Hell, who had half a century earlier been accused by Littrow of forging records of observations of the Transit of Venus. By protracted study of the original manuscripts, Newcomb was led to suspect that Littrow could not see differences in color between inks, and on inquiry learned that he was color-blind.

No further research was necessary. For half a century the astronomical world had based an impression on the innocent but mistaken evidence of a color-blind man respecting the tints of ink in a manuscript (p. 160).

It was not the only occasion on which Professor Newcomb inferred a fatal flaw in eyesight from faulty work. On taking charge of the Nautical Almanac Office he found that his proof-reader could not read proofs—he did not appear to see figures, or be able to distinguish whether they were right or wrong, and, therefore, was useless as a proof-reader. "It is not his fault," was the reply; "he nearly lost his eyesight in the civil war, and it is hard for him to see at all." In the view of counsel this ought to have settled the case in his favor (p. 215). We may put alongside this story Airy's condition of efficiency in another kind of assistant. "I never," he said, "allow an operator who can speak with the instruments to take part in determining a telegraphic longitude" (p. 290). For the explanation we must refer the reader to the book itself.

Airy is referred to by the author as 'the

most commanding figure in the astronomy of our time.' Perhaps the same phrase may be used, with alteration in date, of Newcomb himself. At any rate, his figure is conspicuous enough to justify many times over the autobiographical references in the early part of the book, for which he makes a modest apology in the preface. We are sure that the opinion of the friends who urged their publication will be endorsed by a wide circle of readers. To be able to identify the Newcomb we know—the man who courageously set out to reduce to order a vast mass of heterogeneous accumulated observations, and who did it—with the child who taught himself to add by using a bed-quilt as an abacus; with the boy who listened to an astronomical lecture by his father (somewhat as J. Homer Lane afterwards listened to Newcomb himself) and then said, 'Father, I think you were wrong in one thing' (the story is told by the father); with the youth who was apprenticed to a quack doctor and ran away because he could not stand the quackery; with the man who became perforce a soldier at a moment's notice —there is surely nothing of harm in our being allowed this possibility, and equally surely there is much of good. We are grateful to the author for putting aside his own natural feelings in the interests of his readers.

A critic is morally bound to devote one paragraph to complaints, and we will complain of some deficiency in references. There is, for instance, a chapter on 'Scientific England,' describing a visit to Europe with no date attached. After looking through the chapter in vain for a date, we turned to the index for the eclipse which is referred to several times in the chapter as supplying the motive for the expedition. It is not mentioned in the index! Another eclipse (that of 1860, observed in America by Newcomb) is indexed, but there is no reference to the one mentioned at least half a dozen times in Chapter X.

But having fulfilled this critical duty, we gladly return to the more congenial attitude of commendation, and say that the book is beautifully printed, and that there is an excellent portrait of the author as a frontispiece, which is in itself enough to make the book worth buying.

H. H. TURNER.

UNIVERSITY OBSERVATORY, OXFORD,
November 11, 1905.

Naturkonstanten in alphabetischer Anordnung. By Professor Dr. H. ERDMANN and Privatdocent Dr. P. KOETHNER. Berlin, Julius Springer. 1905. 8vo. Pp. 192.

This book on 'Constants of Nature' is mainly a collection of tables, containing such information as, in the opinion of the authors, is most frequently needed in chemical and physical calculations. The selection made seems in general to be a good one, though some additions might have made it more useful to the physicist. For example, there is no table of the density of mercury at different temperatures, no magnetic data, and under the discussion of temperature measurement no mention of thermocouples or pyrometers.

The subject matter is arranged alphabetically and the book is furnished with a handy thumb index. In the selection of headings two distinct principles have been employed. We find (1) the chemical elements—including their salts—with the most important data relating to them and (2) a discussion of physical and chemical methods of measurement with tables containing the numerical constants for various substances. For example, under 'Iron' the density, melting point and boiling point of the element, the lines of its arc and spark spectrum are given; then follow the molecular weight and density of twenty, the solubility at different temperatures of seven iron salts, the multiples and their logarithms of the atomic weight, the specific gravity of $FeSO_4$, $FeCl_3$ and $Fe_2(SO_4)_3$ solutions of different concentration and finally the logarithms of constants, frequently used in chemical analyses, for example

$$\log \frac{Fe_2}{FeO} \text{ or } \log \frac{FeSO_4 + 7aq}{FeO_3}.$$

This will show the great usefulness of the book, especially for chemical work. Such an arrangement proves in a great many cases more convenient and—if we can speak of such a thing in a collection of tables—more inter-

esting than the arrangement usually followed.

Interlarded with the elements are the separate headings for chemical, physical and mathematical constants, for instance: Analysis, solutions, acoustic, electric, optical and critical constants, logarithms and antilogarithms. The table of atomic weights is based on the values, published by the international committee for 1905.

In some of these cases it might have been better to combine such headings as 'Barometer,' 'Gases' (with reduction of barometric readings) and 'Air'—or 'Freezing Mixtures,' 'Temperature Measurement,' 'Thermochemistry' and 'Heat Constants,' instead of having each in a different part of the book. There are, however, a large number of cross references and an excellent index to facilitate its use.

In these chapters on constants the authors have added some text, containing definitions, derivations and explanations of the more important formulæ, and frequent valuable references to the literature. The chapter on 'Units' is the weakest part, since several mistakes and many loose statements have crept in which should not occur in a book of this kind. The gram is defined as the weight of one cubic centimeter of water at 4° C., instead of the concrete unit; density and specific gravity are used as synonyms. While the numerical values may be identical, namely, if we adopt as unit volume the milliliter, or the wrong definition of the gram (as mass) given by the authors, the two names have not the same physical meaning. The metric equivalent of the English yard is given incorrectly and as the two units of capacity in the United States we find the gallon and the cask, the latter to equal 121.1296 liters. The reviewer feels confident that with him many readers of SCIENCE are ignorant of the existence of such a unit, though certainly one of this size might exist in addition to the many others. The bushel, however, is not given. It would have been well to add to the metric horsepower, as used in Germany, the equivalent of the English horsepower. The electrical units have not been defined in accordance with international agreement or with the values legalized in Germany; that the E.M.F. of a Clark standard cell is given as 0.69735 volt—the reciprocal of its actual value—may be an oversight.

A distinction, though by no means clear, seems to be made between 'Masse,' 'Gewicht' and 'Schwere,' the second probably corresponding in meaning to Holman's 'Weightal,' *i. e.*, the quantity of substance as measured by weighing; but the use of the first two as synonyms and the statement that the gram-weight is one of the units of the c.g.s. system (see also: One Joule = 0.1019 mkg.) leads finally to an evaluation of the 'weight' of the sun instead of its mass.

While the reviewer may appear over-particular in such questions, it can not be sufficiently emphasized how harmful mistakes of this kind are. Like a fog in an otherwise beautiful landscape, they have led many a man off the right road. But this book is principally intended for those who have passed the danger point or are not concerned with definitions of this kind, and for such it will prove to be very useful on account of its handy size and the good selection of the material.

K. E. GUTHE.

STATE UNIVERSITY OF IOWA.

Die heterogenen Gleichgewichte vom Standpunkte der Phasenlehre. By H. W. BAKHUIS ROOZEBOOM. Zweites Heft: Systeme aus zwei Komponenten. Erster Teil. 14 x 22 cm.; pp. xii + 465. Braunschweig, Friedrich Vieweg und Sohn. 1904.

In this volume the author discusses equilibrium phenomena for two-component systems in which only the components can occur as solid phases. Compounds and solid solutions are to be considered in a later volume. Mixtures of gases apparently do not come under the scope of the book and the author starts off with the equilibrium between liquid and vapor. We have the boiling-point curves for mixtures which give neither a maximum nor a minimum boiling-point, for pairs of liquids with a constant maximum boiling-point, and for pairs of liquids with a constant minimum boiling-point. We also have the pressure-con-

centration curves for these systems at constant temperature. In addition to a discussion of the possible qualitative forms of the partial pressure curves, there is a consideration of the quantitative values with special reference to the formulas of Duhem, van der Waals and van't Hoff. The only thing lacking in this summary is a statement of the relation between the heat of dilution and the displacement of a maximum or minimum boiling-point with change of pressure.

Next in order is a discussion of the complete freezing-point curve. Of special interest is the chapter on the methods of determining the freezing-point curves and the nature of the solid phases. We can locate a freezing-point curve either thermally by cooling- or heating-curves, or analytically by solubility determinations at constant temperature. For aqueous solutions the latter method is usually the more accurate; but the thermal method is the better for alloys and fused salts, owing to the difficulty of pipetting off the pure solution.

Roozeboom groups the methods for determining the nature of a solid phase under the headings: 'Direct Analysis,' 'Microscopic Examination,' 'Conductivity,' 'Electromotive Force,' 'Heat of Formation,' 'Other Methods.' While these methods have all been used more or less extensively, they are of very unequal value. When possible, isolation of the solid phase and direct analysis is the most accurate of all. This, however, is usually not feasible in the case of alloys and is often unsatisfactory with efflorescing salts. Microscopic examination is the only method which is of real value for alloys. The methods grouped under conductivity and electromotive force are worthless as general methods and are not to be recommended in special cases except as giving corroborative evidence. Much the same may be said of density determinations, while no one has ever got any results by determining the heat of formation of alloys.

The last portion of the book is devoted to a consideration of equilibrium under high pressures, the phenomena near the critical points forming a special case under this general heading. While interesting in itself and important from a theoretical point of view, this section will probably appeal less to the average chemist than will other portions of the book, because relatively few of us have ever had the opportunity of working with high pressures.

WILDER D. BANCROFT.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for November contains the following articles: 'Collection and Preparation of Material for Classes in Elementary Zoology,' by B. G. Smith, giving the methods in use at the University of Michigan; 'A New Ostracod from Nantucket, *Cyprinotus americanus*,' by Joseph A. Cushman; 'Further Notes on *Hyla andersonii* and *Rana virgatipes* in New Jersey,' by W. T. Davis; 'A Systematic Study of the Salicaceæ,' by D. P. Penhallow; the concluding paper containing a synopsis of the genera and species and list of literature on the subject. 'Momentum in Variation,' by F. B. Loomis, is an all too brief attempt to explain the development of parts beyond the point of apparent utility. Many of the statements need qualification, many are erroneous, and the subject is not one to be disposed of in five pages; it is safer to say we do not know.

The American Journal of Anatomy for December contains the following articles:

JOHN WARREN: 'The Development of the Paraphysis and the Pineal Region in *Necturus maculatus*.' 23 text-figures.

E. T. BELL: 'The Development of the Thymus.' 3 plates and 5 text-figures.

J. S. FERGUSON: 'The Veins of the Adrenal.' 3 text-figures.

GEORGE WALKER: 'The Blood Vessels of the Prostate Gland.' 2 colored plates.

B. M. ALLEN: 'The Embryonic Development of the Rete-Cords and Sex-Cords of *Chrysemys*.' 1 double plate and 6 text-figures.

F. T. LEWIS: 'The Development of the Lymphatic System in Rabbits.' 8 text-figures.

F. T. LEWIS: 'The Development of the Veins in the Limbs of Rabbit Embryos.' 1 text-figure.

A notice to members of the Association of American Anatomists of the approaching meeting, Christmas week.

The Annual Report of the Public Museum of Milwaukee, for the year ending August 31,

1905. The Milwaukee Museum is to be congratulated on the promptness with which its report has been issued and on the progress made during the year. The special stress laid upon educational exhibits, and its relations with and assistance to the public schools is of interest, as one of many reminders of the great changes that have taken place in museums. The Milwaukee Museum is fortunate in having a small lecture room for the use of schools, although the lectures given are by a special teacher of the public school system, and not by a member of the museum staff. In this connection it is somewhat amusing to note the claims made by different institutions regarding the value of their educational work, and it may be suggested that besides Pittsburg and Milwaukee, the American Museum of Natural History, with its loan collection studied, or at least seen, by 365,000 children and its lectures to thousands of pupils, should not be overlooked. There is also the New York Botanical Garden with its museum and lectures, and the Children's Museum of the Brooklyn Institute with its 100,000 visitors, 25,000 readers and lectures attended by all who can crowd in. However, Scripture says that we should not hide our (educational) lights under bushel baskets, and it is well for the public to know that much earnest effort is being expended to make museums interesting and of value to school children.

SOCIETIES AND ACADEMIES.

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES.

There will meet at New Orleans:

The American Association for the Advancement of Science.—The week beginning on December 28. Retiring president, Professor W. G. Farlow, Harvard University; president-elect, Professor C. M. Woodward, Washington University, St. Louis, Mo.; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Professor C. A. Waldo, Purdue University, Lafayette, Ind.; secretary of the council, Dr. John F. Hayford, U. S. Coast and Geodetic Survey, Washington, D. C.

Local Executive Committee.—Honorary president, President E. B. Craighead, Tulane University; executive president, Professor George E. Beyer, Tulane University; secretary, Henry M. Mayo, The New Orleans Progressive League; treasurer, Mr. Clarence F. Low, of the Liverpool, London and Globe Insurance Company.

Section A, Mathematics and Astronomy.—Vice-president, Dr. W. S. Eichelberger, U. S. Naval Observatory, Washington, D. C.; secretary, Professor L. G. Weld, University of Iowa, Iowa City, Iowa.

Section B, Physics.—Vice-president, Professor Henry Crew, Northwestern University, Evanston, Ill.; secretary, Professor Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Section C, Chemistry.—Vice-president, Professor Charles F. Mabery, Case School of Applied Science, Cleveland, Ohio; secretary, Professor Charles L. Parsons, New Hampshire College of Agriculture, Durham, N. H.

Section D, Mechanical Science and Engineering.—Vice-president, Professor F. W. McNair, Houghton, Mich.; secretary, Professor Wm. T. Magruder, Ohio State University, Columbus, Ohio.

Section E, Geology and Geography.—Vice-president, Professor Wm. North Rice, Wesleyan University, Middletown, Conn.; secretary, Dr. Edmund O. Hovey, American Museum of Natural History, New York, N. Y.

Section F, Zoology.—Vice-president, Professor Henry B. Ward, University of Nebraska, Lincoln, Nebr.; secretary, Professor C. Judson Herrick, Denison University, Granville, Ohio.

Section G, Botany.—Vice-president, Dr. Erwin F. Smith, U. S. Department of Agriculture, Washington, D. C.; secretary, Professor F. E. Lloyd, Teachers College, Columbia University, New York, N. Y.

Section H, Anthropology.—Vice-president, Dr. George Grant MacCurdy, Yale University, New Haven, Conn.; secretary, George H. Pepper, American Museum of Natural History.

Section I, Social and Economic Science.—Professor Irving Fisher, Yale University, New Haven, Conn.; secretary, Dr. J. F. Crowell, Bureau of Statistics, Washington, D. C.

Section K, Physiology and Experimental Medicine.—Vice-president, Professor Wm. T. Sedgwick, Massachusetts Institute of Technology, Boston, Mass.; secretary, Dr. Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

At New Orleans in conjunction with the American Association for the Advancement of Science there will meet:

The American Chemical Society.—President,

F. P. Venable, University of North Carolina; secretary, Dr. William A. Noyes, the Bureau of Standards, Washington, D. C.

The Botanical Society of America.—January 4. President, Professor R. A. Harper, University of Wisconsin; secretary, Dr. D. T. MacDougal, N. Y. Botanical Garden, Bronx Park, New York City.

The Association of Economic Entomologists.—January 1, 2, 3. President, Professor H. Garman, Lexington, Ky.; secretary, Professor H. E. Summers, Ames, Iowa.

At Ann Arbor will meet:

The American Society of Naturalists.—President, Professor William James, Harvard University; secretary, Professor W. E. Castle, Harvard University. President (Central Branch), Professor H. H. Donaldson, University of Chicago; secretary, Professor W. J. Moenkhaus, Indiana University. The Eastern Branch will not meet this year.

The American Society of Zoologists (Eastern and Central Branches).—December 28, 29, 30. President (Eastern Branch), Professor W. E. Castle, Harvard University; secretary, Professor H. S. Pratt, Haverford College. President (Central Branch), Professor Frank R. Lillie, University of Chicago; secretary, Professor C. E. McClung, University of Kansas.

The Society of American Bacteriologists.—December 28, 29, President, Professor Edwin O. Jordan, University of Chicago; secretary Professor Frederic P. Gorham, Brown University, Providence, R. I.

The American Physiological Society.—December 27, 28. President, Professor W. H. Howell, the Johns Hopkins University; secretary, Professor Lafayette B. Mendel, New Haven.

The Association of American Anatomists.—December 27, 28, 29. President, Professor Charles S. Minot, Harvard Medical School; secretary, Professor G. Carl Huber, 333 East Ann St., Ann Arbor, Mich.

The Society for Plant Morphology and Physiology.—December 27, 28, 29. President, Professor E. C. Jeffrey, Harvard University; secretary, Professor W. F. Ganong, Smith College, Northampton, Mass.

At New York City will meet:

The Astronomical and Astrophysical Society of America.—December 28. President, Professor Simon Newcomb; secretary, Professor Geo. C. Comstock, Washburn Observatory, Madison, Wis.

The American Physical Society.—December 28, 29. President, Professor Carl Barus, Brown University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Mathematical Society.—December 28, 29. President, Professor W. F. Osgood, Harvard University; secretary, Professor F. N. Cole, Columbia University.

At Cambridge will meet:

The American Psychological Association.—December 27–29. President, Professor Mary Whiton Calkins, Wellesley College; secretary, Professor Wm. Harper Davis, Lehigh University.

The American Philosophical Association.—December 27–29. President, Professor John Dewey, Columbia University; secretary, Professor John Grier Hibben, Princeton University.

At Ithaca will meet:

The American Anthropological Association.—December 27–29. President, Professor F. W. Putnam, Harvard University; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

At Ottawa will meet:

The Geological Society of America.—December 27, 28, 29. President, Professor Raphael Pumpelly; secretary, Professor Herman L. Fairchild, Rochester, N. Y.

THE AMERICAN PHYSICAL SOCIETY.

THE fall meeting of the Physical Society was held in Fayerweather Hall, Columbia University, New York City, on Saturday, October 28, 1905. President Barus presided.

The society adopted the following minute expressive of the great loss sustained by itself and by the world of science in the death of our vice-president, our colleague and our friend, Professor DeWitt Bristol Brace, on October 2, 1905.

It was under the shadow of this bereavement that the autumn meeting of the society was convened—a bereavement which is a personal one to nearly every member of the organization. A frequent contributor to the program, a vice-president of the society, a charter member, and the genial friend of every other member, Professor Brace will be long and keenly missed by every one of us. For not only have our proceedings been enriched by his contributions to knowledge, but those in attendance upon our meetings have always been inspired by his devotion to pure science,

by his clear grasp of the vital connection between fact and theory and by his experimental skill.

Born at Wilson, New York, on January 5, 1859, he took his bachelor's degree at Boston University in 1881, at the same time specializing in physics at the Massachusetts Institute of Technology. In his graduate work, he had the good fortune to come under the influence of Rowland and Helmholtz, with the latter of whom he took his doctor's degree. Two years of mathematical physics with Kirchhoff was also a potent factor in his development.

His researches, covering a wide range of optical subjects, are described mainly in *Wiedemann's Annalen*, the *Philosophical Magazine*, the *Astrophysical Journal* and the *Physical Review*, during the twenty years following 1885, when his doctor's dissertation appeared in the first-mentioned periodical.

Those who were associated with him as students at Baltimore and Berlin, those who have worked with him as colleagues in the University at Lincoln, those students who have come under his guidance in the laboratory and those who have accepted the generous hospitality of his home, unite in admiration of the fine qualities of mind and the high ideals which made him at once a successful teacher and an effective investigator.

His modesty was innate, his courtesy never failing, his energy and singleness of purpose a powerful stimulus to all who knew him.

The papers presented were as follows:

GEO. A. HULETT: 'Standard Cells with Electrolytic Mercurous Sulphate as Depolarizer.'

F. L. TUFTS: 'The Phenomena of Ionization in Flame Gases and Vapors.'

L. A. BAUER: 'Instruments and Methods used in the Magnetic Survey of the North Pacific Ocean by the Carnegie Institution of Washington.'

F. C. BLAKE and C. R. FOUNTAIN: 'The Transmission and Reflection of Electric Waves by Screens of Resonators and Grids.'

CARL BARUS: 'The Nucleation of Dust-free Air, Energized or not, Observed at Successively Increasing Supersaturation.'

C. C. TROWBRIDGE: 'The Duration of the After Glow Produced by the Electrodeless Discharge.'

E. L. NICHOLS and ERNEST MERRITT: 'The Decay of Phosphorescence in Sidot Blende.'

FANNY COOK GATES: 'The Conductivity of the Air due to the Sulphate of Quinine.'

C. D. CHILD: 'The Conductivity of the Vapor from a Mercury Arc.'

E. B. ROSA: 'The Construction and Measurement of Standards of Inductance.'

E. B. ROSA and N. E. DORSEY: 'Preliminary Report on a New Determination of v, the Ratio of the Electromagnetic and Electrostatic Units.'

The next meeting of the society—the annual meeting—will be held in New York City, December 29–30, 1905.

ERNEST MERRITT,
Secretary.

THE GEOLOGICAL SOCIETY OF WASHINGTON.

AT the 170th meeting of the society, on November 8, the following papers were presented. Mr. C. D. Walcott discussed 'The Cambrian of Western Utah.'

The Morrison Formation and its Relations with the Comanche Series and the Dakota Formation: Mr. T. W. STANTON.

The Morrison formation is the dinosaur-bearing horizon, long known as the Atlantosaurus beds, lying between the Red Beds and the Dakota formation along the foothills of the Front Range in Colorado. Similar beds of approximately the same age occur widely distributed in the Black Hills region, Wyoming, Montana and western Colorado. The deposits are all non-marine and they have usually been referred to the Jurassic on account of the character of the reptilian fauna, though some authorities have recently assigned them to the Lower Cretaceous.

In Texas there is a great development of marine Lower Cretaceous rocks known as the Comanche series. The upper, or Washita, group of this series extends beyond the lower groups toward the north and west, so that in southern Kansas and eastern New Mexico it rests on the Red Beds, and, as it is limited above by the Dakota formation, it there seems to hold the same position as the Morrison formation in the general geologic column.

The work of Messrs. W. T. Lee and N. H. Darton during the past three or four years

has extended the known limits of the Comanche series with its marine fossils to the northwest corner of Oklahoma and into northeastern Colorado, and it has also proved the extension of the Morrison formation into the same area. These geologists believed that they had traced the Morrison formation laterally into the marine beds of the Comanche series and that they had thus proved it to be of the same age.

During the past summer the area in question was examined by Messrs. Lee, Stanton and Gilmore and it was found that the beds containing the Comanche fauna overlie the Morrison formation wherever both horizons occur in the same section. This relation was seen on Purgatoire River south of La Junta, Colorado; on the Cimarron from Garrett, Oklahoma, to the neighborhood of Folsom, New Mexico; on the Canadian north of Tucumcari, New Mexico; and finally in Garden Park, near Canyon City, Colorado, at the noted locality for Morrison vertebrates. At all these localities the Comanche horizon has previously been included among the beds referred to the Dakota, and the error in correlation when the Comanche fossils were supposed to have come from beds of Morrison age was due to the failure to locate the fossils accurately in the local sections. The Morrison formation underlies all the Comanche beds that extend into the same area, and is, therefore, distinctly older than those with which it was supposed to be contemporaneous. The question whether it is Upper Jurassic or Lower Cretaceous is still left open. The Dakota formation is much more intimately connected with the Comanche series than is the Morrison.

The Subdivisions of the Shenandoah Limestone: Mr. R. S. Bassler.

The name Shenandoah limestone proposed by Darton for the Valley limestone of early geologists was made to include all the limestones in the Valley of Virginia occupying the interval between the Cambrian quartzites and the Upper Ordovician shales. The lower portion of the great limestone series had been found by Mr. Walcott to include Lower, Middle and Upper Cambrian rocks, but the Ordovician portion had been determined only to the extent that Trenton strata were supposed to occur at the top. The work of the writer in Virginia brought out the fact that the geologic succession of the Ordovician division was quite different in various parts of the Valley. In northwestern Virginia a great thickness of Beekmantown is overlaid by 1,000 feet of Stones River, and this in turn by 400 feet of Black River, while the strata-bearing Trenton fossils form the lowest division of the overlying shales. In central western Virginia the Black River alone rests upon the Beekmantown, but in southwestern Virginia two distinct arrangements were noted. Along the western edge of the Valley the Beekmantown is followed by 1,000 or more feet of Stones River but no Black River, while along the eastern side only the Black River occupies the interval between the overlying shales and the Beekmantown. In each case the Trenton does not form the upper part of the limestone, but is the basal member of the overlying shales.

The Shenandoah limestone, therefore, is a broad term, embracing strata of Cambrian and Ordovician age, the geologic succession of the latter varying in different parts of even the type area.

M. L. Fuller,
Secretary pro tem.

THE NATIONAL GEOGRAPHIC SOCIETY.

The National Geographic Society, whose headquarters are in Washington, will conclude the eighteenth year of its history on December 31 of this year. The society has a membership of considerably over 10,000, which makes it the largest geographical association in the world. About 1,400 of its members reside in Washington, while the others are well distributed throughout the United States and in foreign countries. The annual dinner of the society will be held at the New Willard in Washington, D. C., on December 20. The Secretary of War, Hon. William H. Taft, and Mrs. Taft will be the guests of honor of the society. The following program of meetings for 1905 and 1906 has been arranged for Washington. The majority of the addresses are published in the magazine of the society.

PROGRAM OF MEETINGS.

The Popular Course.

November 10.—'A Review of the Russo-Japanese War—from the Sinking of the *Variag* to the Signing of the Treaty of Portsmouth,' by Mr. Robert L. Dunn, special correspondent of *Collier's Weekly* in the far east.

November 24.—'The Panama Canal,' by Hon. James R. Mann, member of congress from Illinois.

November 25.—'My Captivity in Morocco,' by Mr. Ion Perdicaris.

December 8.—'What Shall be Done with the Yosemite Valley?' by Mr. William E. Curtis, illustrated. The Yosemite Valley has been receded to the federal government by act of the California legislature, but has not yet been formally accepted by congress.

December 21.—'A Military Observer in Manchuria,' by Major Joseph Kuhn, U.S.A., illustrated.

December 22.—'An Attempt at an Interpretation of Japanese Character,' by Hon. Eki Hioki, first secretary of the Japanese legation.

January 5.—'Russia and the Russian People,' by Mr. Melville E. Stone, general manager of the Associated Press. It will be remembered that it was Mr. Stone who two years ago persuaded the Czar Nichols to grant freedom from the censor to foreign correspondence from St. Petersburg.

January 9.—'The Ziegler Polar Expedition of 1903–1905,' by Messrs. W. S. Champ, Anthony Fiala and W. J. Peters.

January 19.—'Railway Rates,' by Hon. Martin A. Knapp, president of the Interstate Commerce Commission.

January 31.—'China,' by Hon. Charles Denby, of the state department, and for many years resident in China.

February 2.—'Austria Hungary,' by Edwin A. Grosvenor, LL.D., professor of international law in Amherst College, author of 'Constantinople,' 'Contemporary History,' etc.

February 10.—'A Flamingo City, Bird Life in the Bahamas,' by Dr. Frank M. Chapman, of the American Museum of Natural History.

February 16.—'Africa from Sea to Center,' by Mr. Herbert L. Bridgman, illustrated. Africa in transition to-day challenges the attention of the world. Few intelligent Americans know to what extent its possibilities have been developed since Livingstone's day, a development that in rapidity promises to exceed that of North America.

February 23.—'The Personal Washington,' by Mr. W. W. Ellsworth, of the Century Company, illustrated. This is not a lecture in the ordinary sense of the word, but it is an exhibition, through the medium of the stereopticon, of the greatest collection of prints, manuscripts and letters referring to the personal side of Washington ever brought together.

March 2.—'Our Immigrants: Where They Come from, What They Are and What They Do After They Get Here,' by Hon. F. P. Sargent, U. S. commissioner general of immigration, illustrated.

March 16.—'Oriental Markets and Market Places,' by Hon. O. P. Austin, chief U. S. Bureau of Statistics, illustrated.

March 30.—It is hoped that official business will permit the secretary of the navy, Honorable Charles J. Bonaparte, to address the society on 'The American Navy.'

April 13.—'The Regeneration of Korea by Japan,' by Mr. George Kennan, illustrated.

Scientific Meetings.

November 17.—'Morocco,' by Mr. Ion Perdicaris.

November 22.—'Sixteen Years in China,' by Rev. Charles A. Killie, F.R.G.S., official photographer of the siege of Peking, illustrated.

November 29.—'The Panama Canal,' by Mr. Bunau-Varilla.

December 1.—'The Development of the Mineral Resources of Alaska, with particular reference to the Fairbanks and Nome Regions,' by Mr. Alfred H. Brooks, chief of the Alaskan Division U. S. Geological Survey.

December 15.—'Surveying our Coasts and Harbors,' by Hon. O. H. Tittmann, superintendent U. S. Coast and Geodetic Survey.

December 29.—'Problems for Geographical Research,' by Gen. A. W. Greely, U.S.A. 'The Binding Power of Road Material,' by Mr. A. S. Cushman.

January 12.—Annual meeting. Reports and elections. 'Progress in the Reclamation of the West,' by Mr. F. H. Newell, chief engineer reclamation service.

January 26.—'The Carnegie Institution,' by President R. S. Woodward.

February 9.—'The Introduction of Foreign Plants,' by Mr. David G. Fairchild, agricultural explorer, U. S. Department of Agriculture.

February 24.—'Hunting with the Camera,' by Hon. George Shiras, member of congress from third district, Pennsylvania.

March 9.—'The United States Bureau of the Census,' by Hon. S. N. D. North, director.

March 23.—'The Death Valley,' by Mr. Robert H. Chapman, U. S. Geological Survey.

April 6.—'The Total Eclipse of the Sun, July, 1905, as Observed in Spain,' by Rear Admiral

Colby M. Chester, U.S.N., superintendent U. S. Naval Observatory.

April 20.—'The Protection of the United States against Invasion by Disease,' by Dr. Walter Wyman, surgeon-general Marine Hospital Service.

The Magazine.

The magazine of the society contains many large colored maps. Four such maps were published in the 1905 volume: (1) A chart of the world, 25 x 45 inches, and in four colors, showing all submarine cable systems and connections and the steamship routes of the world; (2) a map of northern Manchuria, in two colors, 18 x 44 inches; (3) a map of the Philippines, in four colors, 23 x 36 inches; (4) a map of the Panama Canal region, in five colors, 24 x 33 inches. The magazine is very handsomely illustrated. All members of the society receive the magazine free of charge.

THE TORREY BOTANICAL CLUB.

The meeting of October 10 was held at the American Museum of Natural History, with President Rusby in the chair and twenty-two persons present.

A letter was read from Mr. Edward W. Berry, tendering his resignation as recording secretary of the club, owing to his removal to Baltimore.

The announced program for the evening consisted of informal reports on the summer's work and observations. Several from whom reports were expected were unable to be present.

Professor Francis E. Lloyd gave an account of his summer's experiences at the Desert Botanical Laboratory of the Carnegie Institution at Tucson, Arizona. On the way thither a visit was made to the Tularosa Desert in southern New Mexico. This desert is largely an old lake bed of a comparatively recent geological period. The moving white sands which compose the desert overlie the mesa and consist chiefly of gypsum, and a little below the surface there is a considerable amount of available water, which, however, is saline. The vegetation of the region is peculiar, showing various adaptations to the intense light. Several interesting cases were observed showing how yuccas and other plants are able by continued vertical growth to keep their tops above the drifts of sand and how in the process they help to build up and hold the dunes. *Rhus trilobata* and also a shrubby labiate form very marked pillar dunes. The gypsum sand is partly soluble and it solidifies about the vertically elongating roots and stems; the outer parts of the dune may then erode and be removed by the wind, leaving an isolated pillar-like mass surmounted by the tops of the living shrubs. An interesting and not especially common plant of the region of Tucson is *Cereus Greggii*, of a habit so peculiar and aberrant that it does not seem to be a *Cereus* at all. Like certain other desert plants it has an underground storage system which is very large in comparison with the above-ground parts. The rapidity with which foliage appears on desert plants after rains has been often noted, and it has been a question in how far growth of leaves may be stimulated by the direct access of water to the above-ground parts without the intervention of the root-system. This point was tested during the past summer by experiments at the Desert Botanical Laboratory. By means of a siphon, water was supplied directly to the leaf-buds and stems, in such a way as to prevent the water from reaching the ground. It was found that the desert plants thus stimulated produce leaves in the course of a few days. Very noticeable changes occur within twenty-four hours, both when plants are stimulated as described and after natural irrigation by rains. Professor Lloyd further observed diurnal nutations and nyctitropic movements in an amaranth growing near the Desert Laboratory. Photographs were shown illustrating the observations commented upon.

Dr. William A. Murrill spoke briefly of his collections of fungi during the summer at Ohio Pyle, Pa., in the District of Columbia and in the Mt. Katahdin region of Maine, describing also some of his camping experiences in the Maine woods. Dr. Murrill was impressed by the boreal character of the fleshy fungi found about Mt. Katahdin, many of them recalling species that he had collected in Sweden.

President Rusby reported on a Torrey Club

excursion to Pompton Plains, New Jersey, where *Capnoides flavulum* was among the rare plants obtained; also on a club excursion to Great Island, New Jersey. Great Island is a hummock of sand surrounded by a salt marsh and lying between Newark and Elizabeth; it has numerous interesting plants, some of them being characteristic of the pine-barren flora of the region further south.

Professor E. S. Burgess remarked upon his summer's visit to the Pacific Coast. Collections and field studies of asters were made in New Mexico, Arizona, California and Oregon. Mt. Hood, Ore., proved an especially interesting field. Asters were found growing there in close proximity to snow and ice.

Mrs. Britton alluded briefly to collecting experiences in Bermuda during September. Most of the species of ferns, mosses and hepatics are found there only in the 'caves' or sink-holes. Her collections indicate considerable additions to the list of mosses published in the Report of the *Challenger* Expedition.

Dr. J. H. Barnhart spoke of the International Botanical Congress held at Vienna in June, which he attended as a delegate from the New York Botanical Garden.

MARSHALL A. HOWE,
Secretary pro tem.

THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

THE second regular meeting of the New York Section, American Chemical Society, was held at the Chemists' Club, 108 West 55th Street, Friday, November 10, at 8:30 P.M., with an attendance of 78. The chairman, Dr. F. D. Dodge, presided.

Chrome Tanning: OTTO P. AMEND.

The first really important advance in practical chrome tanning was undoubtedly made by August Schulz in 1884. Schulz treated his skins in a bath containing bichromate of potash plus an acid until they were saturated, and after this they were placed in a second bath containing sulphurous acid or hyposulphite of soda plus an acid. This process has since been called the two bath process.

The one bath process consists in treating the skins with a basic solution of a chromic salt. Such a salt can be produced by adding washing soda to a chromium salt until sufficiently basic and then heating.

Differences in basicity have an important bearing on the tanning properties of chrome solutions. Chrome alum, on account of its acid character, penetrates the skin quickly, but fails to tan the skin thoroughly, is easily washed out, and produces leather of a greenish color. When more basic solutions are used, the penetration is slower, the tannage more complete, the chrome less easily washed out and the leather produced is of a more bluish shade. When the solution becomes very basic, the chromium salt will precipitate on dilution, but remains stable and perfectly dissolved in a concentrated solution.

Analysis of a number of chrome liquors on the market show that nearly all of them are produced by the reduction of bichromate of potash or soda, by means of glycerin, alcohol or glucose; most of them being sulphates.

5-Brom-2 Amino-benzoic-Acid and some of its Derivatives: MARSTON TAYLOR BOGERT and WILLIAM FLOWERS HAND.

5-Brom-2-acetaminobenzoic acid was prepared by direct bromination of acetanthranilic acid, and also by the oxidation of 5-brom-o-acettoluid. On saponification, it gave the 5-brom-2-aminobenzoic acid, while boiling acetic anhydride changed it to 5-brom-2-acetanthranil. 5-brom-2-acetaminobenzonitrile was obtained by the direct bromination of acteanthranilic nitrile. The above compounds were described, together with certain of their derivatives.

Fischer's Classification of Stereo-Isomers: M. A. ROSANOFF.

The author demonstrates that Emil Fischer's subdivision of the sugars and their derivatives into two enantio-morphous families is erroneous in a number of cases and therefore self-contradictory. He proposes a corrected classification which brings out the family relationships, of those compounds with great clearness, settles definitely the controversies that have arisen on the subject, and eliminates much

current misapprehension. For example, ordinary tartaric acid, generally considered as a relative of ordinary glucose, is presented by the new classification as a relative of the antipodal, levo-rotatory glucose. As a matter of fact, ordinary glucose changes, gradually, to arabinose, erythrose, threose, and, not ordinary, dextro-rotatory, but the levo-rotatory tartaric acid.

Chemical Examination of Æthusa Cynapium: FREDERICK B. POWER and FRANK TUTIN.

The *Æthusa Cynapium* Linn., or 'fool's parsley,' known also as the 'lesser hemlock,' is a well-known annual garden weed, which is indigenous to Europe and northern Asia, and is the only representative of the genus. Numerous cases of poisoning have been attributed to this plant, in most of which it appears to have been mistaken for common garden parsley.

The author was led to take up his investigation because of the conflict of opinion as to the poisonous properties of the plant. He reports finding a small amount of an essential oil of a rather unpleasant odor, corresponding to 0.015 per cent. of the weight of the entire fresh plant. An amount of resinous substances corresponding to 0.8 per cent. A small amount of *d*-mannitol from which a hexaacetyl derivative was prepared. A considerable amount of inactive glucose and amorphous coloring matter, and an exceedingly small amount of volatile alkaloid, having the peculiar characteristic odor of coniine, and which like the latter yielded butyric acid on oxidation.

F. H. POUGH,
Secretary.

THE UNIVERSITY OF COLORADO SCIENTIFIC SOCIETY.

DURING September and October, 1905, the society held six meetings with programs as follows:

PROFESSOR WILLIAM DUANE: 'Recent Discoveries in Radioactivity.'

PROFESSOR R. D. GEORGE: 'The Cœur d'Alene Mining District.'

DR. LUMAN M. GIFFIN: 'A Quarter-Century Evolution of Medical Education.'

PROFESSOR JOHN A. HUNTER: 'Tungsten Steel.'

PROFESSOR T. D. A. COCKERELL: 'Characters of Rocky Mountain Flora.'

DR. J. E. WAXHAM: 'Medical Ethics.'

DEAN F. B. R. HELLEMS: 'A Bronze Tablet and its Relation to Roman Constitutional History.'

The average attendance at the meetings was forty. Membership is not restricted to those connected with the university but is open to citizens of Boulder. A number of business and professional men have joined the society.

FRANCIS RAMALEY,
Secretary.

BOULDER, COLO.,
November 5, 1905.

THE CLEMSON COLLEGE SCIENCE CLUB.

THE 58th regular meeting of the Clemson College Science Club was held on Friday evening, October 25. Dr. Metcalf, Professor Chambliss and Professor Howard gave informal talks on their summer's work. Dr. Metcalf and Professor Chambliss spent several months in the rice fields of South Carolina, the former studying diseases of rice and the latter the insects injurious to the plant. A full report of rice diseases will shortly appear in a government publication. Professor Chambliss found the number of insects injurious to the rice plant to be twenty-one instead of eight, as formerly reported. One of the species found is undoubtedly new.

The principal paper of the evening was by Professor J. N. Harper, on 'The Breeding of Wheat.' It was based on experiments which he has carried on for the past three years and the conclusion reached was that the amount of protein in the wheat grain can be increased by physical selection and that the increased amount can be recognized by physical tests.

FRED H. H. CALHOUN,
Secretary.

THE ELISHA MITCHELL SCIENTIFIC SOCIETY.

THE 162d meeting of the society was held on November 14, when the following program was presented:

MR. J. E. LATTA: 'A Note on Electrocution.'

MR. N. C. CURTIS: 'Pillet's Method of Finding the Shortest Distance between two Lines.'

MR. R. O. E. DAVIS: 'The Theory of Electrons.'

A. S. WHEELER,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

THE ARRANGEMENT OF MEETING ROOMS.

As the season of winter meetings approaches it may be permissible to make a few suggestions regarding the transformation of college lecture rooms into meeting rooms for scientific societies.

The ordinary college lecture room is arranged, properly enough, in a two-party fashion. The lecturer is on one side of the desk and the students are on the other. But a society meeting room should be arranged in a three-party or triangular fashion, so that the president and the secretary can see and can be seen by the two other parties, namely, the speaker and the members. If this principle is neglected, as is too often the case, and the president and the secretary are placed at the same desk with the speaker, various awkward results are likely to follow. The speaker is very apt to turn his back on the officers and to talk only to the members—if indeed he does not also turn his back on the members and talk only to the blackboard. The president, sitting with his back to the diagrams that are referred to by the speaker, is tempted to perform various twists in trying to see what is behind him. The members, finding two persons in line with the diagrams, do not always see clearly what it is intended that they should see.

These various difficulties disappear if the three-party arrangement is adopted. The speaker is then given sole possession of the lecture platform and desk, with the blackboard and racks behind them. The president and the secretary are given a table (with a platform also, if necessary) on the floor at one end and somewhat in front of the lecture desk, far enough forward for them to see the speaker and the blackboard when they look a little to one side, and high enough for them to see the members when they look to the other side. The members, from the ordinary seats, can then see both the speaker and the officers; the officers can see both the speaker and the members; and the speaker can observe the proprieties all through his remarks by looking at the officers and the members in turn. The only chance of awkwardness comes if the speaker takes his place at the end of the desk near the officers' table, for he may then turn his back on them, while pointing to his diagrams. To prevent this involuntary discourtesy the space behind the desk at the end near the officers' table should be blocked up, so that it can not be entered or occupied. The speaker will then necessarily enter from the other end and stand with his face turned toward the other two parties in the triangle; unless, as said before, he insists on facing only the blackboard. Inasmuch as speakers ordinarily use their right hand for chalk work it seems most generally satisfactory to place the officers near the left end of the lecture desk, as seen from the audience, and to keep the speaker near the right end.

Several other items may be briefly indicated. Some form of racks for diagrams should be provided beforehand, with simple means of attaching the diagrams and of raising the racks; spring clothes pins are of quieter action than tacks that have to be hammered: if the racks are hoisted by a cord over pulleys, the pulleys should have all squeaks reduced by oiling. The duty of darkening the room when the lantern is used should be assigned beforehand to a responsible and well-practised person of regular habits. Attention should be given to the windows, especially to the upper sashes, to see if they can be opened easily for ventilation, without over-much squeaking or slamming, and without conspicuous gymnastics on the part of the secretary; examples might be cited in which the antics performed in favor of ventilation have completely distracted the attention of the members from the matter presented by the speaker, which after all is usually the more important of the two forms of entertainment. If there are windows near the lecture desk, they should be darkened, so that the speaker and the officers shall not be recalled chiefly as blackened characters silhouetted against the light of outdoors in the eyes of the audience. If the entrance is at the back of the room an usher will be of value in urging members into the forward seats 'at the request of the presi-

dent'; for an audience on the back benches, leaving the front benches empty, can not be regarded as encouraging to the speaker. A young page at the service of the president and secretary is an appropriate luxury; he can be waked when messages have to be sent. A lobby into which members can retire for conversation is indispensable for a comfortable meeting; it should not be so near the meeting room that laughing in one drowns speaking in the other. As to the manner of presentation of scientific communications by the speakers, that is too sacred a question for us to enter upon. Individuality must be preserved at all hazards. But if a distinction *could* be drawn between the form in which a problem is prepared for publication and the form in which it is presented orally to a listening audience, and if the effect to be produced upon the audience *could* be duly considered by the speaker, scientific meetings would be even more successful than they are now.

One other practical suggestion may be allowed. It would be an assistance if the local committees would write down the more important results of their experience in a *transmittendum,* to be passed on to their successors. Thus, even if new mistakes were occasionally invented, old mistakes might be more generally avoided, and a greater enjoyment and profit might be secured for all concerned by the gradual removal of various trifling inconveniences and distractions which have no place in well-conducted meetings.

A FELLOW OF THE ASSOCIATION.

SPECIAL ARTICLES.

NOTE ON THE FALLING-TO-PIECES OF THE IONS.

1. THE data summarized in the following graphs were obtained by acting in the manner stated, on the dust-free moist air contained within a glass fog chamber, with a sample of weak radium (10,000 $\times$, 10 mg.), sealed in an aluminum tube. This was placed on the outside of the chamber in contact with its walls (.2 to .3 cm. thick), and was then removed suddenly at given intervals before exhaustion. Only very penetrating primary rays (β and γ) are, therefore, in question. The curves show the number of efficient nuclei in thousands per cubic centimeter, observed after the lapses of time shown by the abscissas, and it is supposed that the nuclei are reproduced faster than they can be removed by the exhaustion. In the upper curve the pressure differences applied ($\delta p = 31$) are much above the fog limit of dust-free air, which is below $\delta p_0 = 24$ for the given apparatus. In the lower curve the pressure differences are nearly at the fog limit of dust-free air, while the other curve ($\delta p = 28$) applies for intermediate conditions. The effect of the radiation is, therefore, virtually at least, a coagulation (to use a figurative expression) of the colloidal nuclei of dust-free air, into the aggregates much larger in size representing the ions. Hence in the presence of radium under the given conditions, the number of *efficient nuclei* decreases either because the ions from their size capture all the available moisture more and more fully, or because the colloidal nuclei have actually been aggregated into fewer but larger systems, which will in turn fall apart in the absence of radium. Professor Barus[1] has recently pointed out that inasmuch as the radiation within the fog chamber is largely secondary, and must, therefore, at a given point come from all directions, a corpuscular pressure must exist within, having a tendency to produce agglomeration; and the same results should occur for an easily scattered undulatory radiation. This would explain why the X-rays and ultra-violet light produce fleeting and persistent nuclei alike in kind, except that only the former are ionized.

2. It follows from what has been stated that above the fog limit of dust-free air, the number of efficient nuclei must increase with the removal of radium at a rate which corresponds to the falling to pieces of the ions. The peculiar feature of the results here in question is the manner in which the efficient nucleation decays from the coarser ionized to the finer non-ionized colloidal stages, when the pressure difference is decidedly above the fog limit of air, so that the latter may be recognized. The curves invariably pass through a minimum

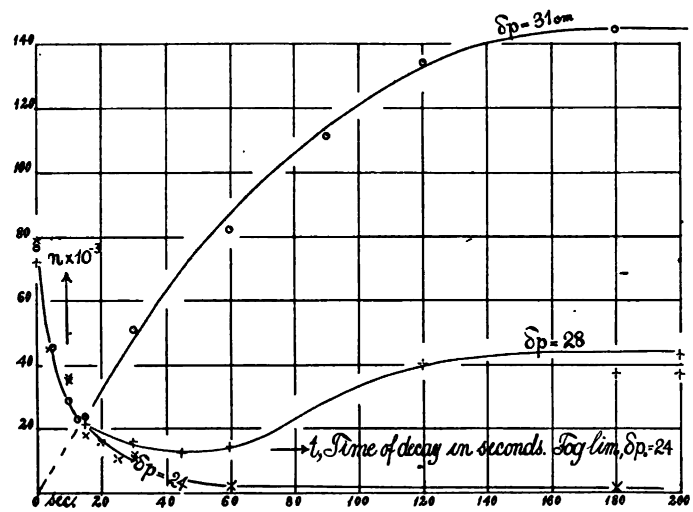
[1] *Am. Jour. Sci.*, (4), XX., p. 298, 1905.

when the time after the removal of the radium, *i. e.*, the interval of decay, increases indefinitely.

This minimum, moreover, is very sharp, almost cusp-like, as if one law were passing abruptly into another. Thus below the minimum ($t = 13$ sec. about) the curve for $\delta p = 31$ nearly coincides with the curve for $\delta p = 24$, which is practically independent of the colloidal nuclei of air. The decay may be computed to be of the order of that of ions. After a lapse of 13 seconds the effect of colloidal nuclei is marked for $\delta p = 31$; and even after a lapse of 60 seconds, when the ions (lower curve) have vanished to a few hundred, the upper curve is only half way on its march toward the asymptote. This shows the remarkable sensitiveness of the method as a test for the presence of ions or of any nuclei larger than the colloidal sizes. Moreover, measurement of the large coronas is relatively easy. Finally, the curve, $\delta p = 31$, if prolonged backwards, would seem to start nearly from the origin; in such a case one would have to picture to oneself a single coagulated particle breaking to pieces in the absence of radiation, into fragments of continually decreasing size, until the débris ultimately numbers 150,000 colloidal nuclei.

The intermediate curve ($\delta p = 28$) also coalesces[2] approximately with the other for lapses of time less than $t = 13$ sec. It has its own minimum, however, and from the lower pressure difference, necessarily its own asymptote at $n = 40{,}000$, since only the coarser order of air nuclei fall within the given limits of condensation in the apparatus used. For the same reason the minimum is lower and later, seeing that the ions are present throughout in relatively greater numbers, as compared with the efficient colloidal nuclei, than was the case at $\delta p = 31$.

3. The curves as a whole have so close a resemblance to the data investigated by Professor Barus for the effect of radium at different *distances* from the fog chamber that the same cause must underlie both series of observations. In the former case (distance effects) any given intensity of ionization between the maximum and the vanishing values may be maintained indefinitely by properly placing the radium tube; in the latter case (decay) all stages are passed through in two or three minutes. Beginning with dust-free non-energized air, the number of efficient nuclei decreases as the number of ions in-



[2] Considered relatively to the wide divergence after $t = 13$ sec. is passed. The coalescence need not be perfect. Small coronas fall out too rapidly for close measurement.

creases (for either or possibly both of the reasons already given) until the condensation takes place wholly on ions. For greater intensities of ionization the number of ions must increase further and hence the efficient nucleation rises again while the curve passes through a minimum.

The curves enable us to make certain interesting comparisons, inasmuch as the same nucleation results from radium decaying for a stated length of time, as results from the action of radium at a certain distance from the line of sight. From the importance of secondary radiation in connection with these observations, such comparisons are probably not simple. The essential feature is the passage of the nucleation through the same stages of variation, whether of size or of number, in both cases, no matter how the given successive intensities of ionization may be produced, or whether they come from within or without.

My thanks are due to Professor Barus for his suggestions and his assistance throughout the research.

Lulu B. Joslin.

Brown University,
Providence, R. I.

A LACUSTRINE APHID.

One would suppose that submerged aquatic plants might wholly escape the attacks of plant-lice and scale-insects. In the *Feuille des Jeunes Naturalistes*, February, 1905, p. 62, G. Goury describes a supposed scale-insect which he found on a submerged petiole of *Limnanthemum* near Fontainbleau, in France. Unhappily, he put it in an aquarium, and the pond-snails (*Limnæa*) devoured it during the night. This prevented him from giving a description, and although he names it *Lecanium limnanthemi*, we can not resist the observation that all he says about it would apply to a leech egg. However, it is possible for aquatic plants to be attacked by aphids, though these do not inhabit the wholly submerged parts. On October 7 of the present year, my wife and I visited a lake in the immediate vicinity of Boulder, Colorado. The shallow water contained a large quantity of *Myriophyllum verticillatum* L., a submerged plant with only small portions projecting above the surface. We were astonished to find that whenever the plant was not wholly submerged it was infested by aphids, usually in enormous numbers. At first I wondered whether they could have come from the adjacent terrestrial vegetation; but an examination of the narrow-leafed cottonwoods (*Populus*) and cockleburs (*Xanthium*) near by did not reveal any aphids. Closer inspection showed that the insects were thoroughly at home on the *Myriophyllum* and were undergoing all their transformations thereon. We brought some home, fully believing that we had something new, but on looking up the literature it was found impossible to distinguish them from the European (and doubtless circumpolar) *Rhopalosiphum nymphææ* (L.), which is said by Buckton to infest water-lilies (to which it is at times very destructive), *Alisma, Butomus, Potamogeton, Hydrocharis, Lemna,* etc.

The following description, from the Colorado material, is given because the available descriptions are somewhat incomplete; it will also be useful in case any doubt should arise as to the absolute identity of the European and American forms.

Winged Form.—Yellowish-olive, with the head, the chitinous plates of the thorax and the antennæ black; the middle of the abdomen also suffused with black; legs black, pallid only at extreme base; wings clear, stigma very light-yellowish, nervures black; nectaries incrassate, with the apical part black, the basal pallid; lateral edges of abdominal segments with alternate light and dark spots, best seen in balsam mount; antennæ on frontal tubercles; third joint with several sensoria on outer side, fifth with a sensorium in a notch not far from apex; surface of joints finely imbricated. Measurements: length of body about 1½ mm., of wing about 2½ mm.; the rest in μ—nectaries, 255; cauda narrow and fairly long, its width 37; anterior tarsus (excluding claws), 120; antennal joints, (3) 225, (4) 165, (5) 150, (6*a*) 97, (6*b*) 225. Wings with branched vein having distance from first branch to second, 620; second to tip of wing, 225.

Apterous Form.—About 2 mm. long, broad,

beak reaching lower edge of middle coxæ. Yellowish-brown or yellowish-olive; an obscure dark suffusion down the middle of the abdomen; antennæ, legs and apical part of nectaries, blackish. A whitish waxy powder on under surface. The young are pale green or pale reddish. The pupæ have more of the bluish-white wax, and have a very distinct dark mark on the middle of the abdomen.

The insects swim well on the surface of the water. T. D. A. COCKERELL.

THE NEW ORLEANS MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE permanent secretary announces that owing to delayed negotiations with the railroads with regard to rates and on account of a printers' strike in Washington, the publication of the preliminary announcement of the New Orleans meeting has unfortunately been delayed. It is probable, however, that the announcement will be mailed to all members of the association from Washington about December 8. Additional information to that contained in the announcement will be found in SCIENCE of December 15 and December 22.

As announced last week the Southeastern Passenger Association, including practically the territory south of the Potomac and Ohio Rivers and east of the Mississippi, has granted a one-fare round trip rate plus 25 cents, and the Central Passenger Association has now adopted the same rate. Other passenger associations will either adopt this rate or with the northern associations a one-fare and one third rate to their southern terminals, the one-fare rate holding for distances south of these terminals. The latter plan has been adopted by the Trunk Line Association, which includes New York, New Jersey, nearly all of Pennsylvania, Delaware, Maryland and West Virginia north of Charleston. This will make a very reasonable rate amounting to about $36 from New York City and $27.75 from Washington.

The plans for the meeting are practically completed and many interesting features will be announced in addition to those already mentioned in these columns. The social features will include a smoker at the Washington Artillery Hall on Friday night, December 29; a general reception on the night of December 30, an excursion on December 31 to the large sugar plantations, receptions by private citizens of New Orleans, and personally conducted trolley rides over the city, particularly through the most interesting old and historic parts. Visits will also be arranged to the many industrial establishments and to the new municipal drainage plant.

The symposium to be held under the auspices of Section K on the subject of yellow fever and other insect-borne diseases is attracting much attention, and many prominent experts have accepted invitations to speak. Professor Farlow, the retiring president, has announced as his subject 'The Popular Conception of a Scientific Man at the Present Day.'

On Monday evening the American Chemical Society will hold it annual subscription dinner, and the visiting members of the Sigma Xi will also hold a dinner at a time and place to be announced later. The hotels have announced reasonable rates, and a full list of these rates, together with a list of boarding houses, will be printed in the preliminary announcement.

The permanent secretary reiterates the announcement on the authority of the best sanitarians in the country that there should not be the slightest fear in the mind of any member of the association that New Orleans will be an unhealthy place at the time of the meeting or that it is now unhealthy. In fact, the brilliant sanitary achievement of last summer in wiping out the yellow fever epidemic should greatly add to the interest of a visit to New Orleans at this time. This fact and the general interest attaching to this unique city, together with the unprecedentedly low railroad rates, should combine to bring about an especially large attendance and particularly from the north and east. A visit to New Orleans and its vicinity is in many ways as interesting as a visit to France or Spain.

SCIENTIFIC NOTES AND NEWS.

DR. WILLIAM M. L. COPLIN, professor of pathology and bacteriology in Jefferson Med-

ical College, has been appointed director of the Department of Public Health and Charities of Philadelphia.

On Charter Day, November 10, Rutgers College conferred the honorary degree of doctor of science upon Professor John E. Hill, head of the department of civil engineering at Brown University.

Dr. Friedjof Nansen will shortly go to London as minister from Norway.

The Ingersoll lecture at Harvard University will be given by Professor Wilhelm Ostwald, of the University of Leipzig, on December 12. The subject is 'Individuality and Immortality.'

President Remsen, of the Johns Hopkins University, gave the chief address at the inauguration of Dr. Charles Lee Smith, of Mercer University, Macon, Ga.

The various expeditions sent out by the Carnegie Museum to the fossil fields of the west have returned. The party under Mr. O. A. Peterson has collected a large amount of material from the Miocene deposits of Nebraska. In Montana Mr. Earle Douglass and Mr. Percy E. Raymond were very successful, the former in collecting vertebrates, the latter in collecting invertebrates, and in studying the relations which the Ordovician of the west bears to that of the eastern portions of the United States. The explorations conducted by Mr. W. H. Utterback led to the discovery and collection of the greater portion of a skeleton of Brontosaurus and of the remains of some smaller dinosaurs.

Mr. R. S. Williams, who has been exploring in the Philippine Islands on behalf of the New York Botanical Garden for about two years, has returned with large collections of herbarium and museum specimens and seeds.

Dr. Wm. Bullock Clark, professor of geology at the Johns Hopkins University, delivered a public lecture on November 13 before the Woman's College of Baltimore on 'Fossils and Geological History.' He will deliver a second lecture on December 11 on 'The Mineral Resources of Maryland.'

Leave of absence for this year by the University of North Carolina has been granted to Dr. James Edward Mills, associate professor of chemistry, and to Mr. Marvin Hendrix Stacy, instructor in mathematics. Dr. Mills goes to Germany to study chemistry. Mr. Stacy will study mathematics at Cornell University.

Professor H. S. Blichfeldt, of the department of mathematics of Stanford University, who is on sabbatical leave this year and who has been studying in Paris, has gone to Berlin to continue his work.

Professor William A. Kellerman, of the Ohio State University, will start on his second annual trip to Guatemala about the middle of December, where he will continue his studies of the mycologic flora. Minor commissions of specialists will be executed gratuitously, so far as time and opportunity may permit, and requests should be sent to Dr. Kellerman at once.

The following movements among the staff of the U. S. Bureau of Plant Industry have been reported to *The Botanical Gazette*: Dr. W. O. Richtmann has returned from a trip to California, undertaken in the interests of camphor and poppy investigations; Mr. W. F. Wight has just returned from Europe, where he spent four months in studying type specimens of plants in various herbaria; Mr. F. H. Hillman recently visited the Pacific coast in order to study the species of dodder which are so troublesome in alfalfa and clover fields; Mr. G. Fred Klugh spent several months in Idaho and Nevada studying the relation of poisonous plants to the sheep trouble known as 'bighead'; Mr. S. C. Hood, who has been in charge of the Vermont station for drug-plant investigations, at Burlington, has returned to Washington for the winter; Professor H. Pittier is about to start on an exploring trip of four or five months' duration in western Columbia, with a special view to a study of the cottons of that region; Mr. T. B. Young has returned to Washington after a season's work at Ebenezer, S. C., where he has been in charge of the drug-plant farm, in cooperation with Mr. J. W. King; Mr. Edgar Brown recently returned from an inspection of the more important seed laboratories of

England, France, Netherlands, Germany, Austria-Hungary and Switzerland; Mr. W. W. Stockberger recently made a trip through the hop-producing sections of the Pacific coast and the state of New York, where the conditions of brewing and of curing hops have been studied; Dr. J. W. T. Duvel is spending some time in Ohio and Illinois investigating the curing of seed corn. It has been found that by proper treatment seed corn of high vitality can be assured at planting time.

THE Central High School of St. Louis announces a lecture course entitled 'Outlines of Human Development,' by Doctor W J McGee, director of the St. Louis Public Museum. The special topics and dates are:

November 24.—'Development of Human Structures and Functions.'

December 1.—'Racial and Inter-racial Development.'

December 8.—'Development of Mentality and Collective Activity.'

December 15.—'Essentials of Social or Demotic Development.'

January 5.—'Development of Laws and Institutions.'

January 12.—'Development of Primitive Arts and Industries.'

January 19.—'Higher Esthetic and Industrial Development.'

January 26.—'Development of Language and Literature.'

February 2.—'Development of Philosophy.'

February 9.—'Conjoint Development of Science and the Broader Humanities.'

The course was arranged by Miss Amelia C. Fruchte and Principal W. J. S. Bryan, of the Central High School.

AT the monthly general meeting of the Zoological Society of London, held on November 14, the Duke of Bedford, president, in the chair, the report of the council for the months of August, September and October was read by the secretary, Dr. P. Chalmers Mitchell, in which it was stated that during those three months 893 additions had been made to the society's menagerie, viz., 288 had been acquired by presentation, 142 by purchase, 280 had been received on deposit, 72 by exchange, and 111 had been bred in the gardens. The report further stated that the number of visitors to the society's gardens during the months of August, September and October had been 263,440, showing an increase of 6,810 on the number for the corresponding period of the previous year. The meeting then adjourned to December 21.

UNIVERSITY AND EDUCATIONAL NEWS.

THE *Harvard Graduate Magazine* for December contains an article by Mr. J. D. Greene, the secretary of the university, on the endowment fund for increase of salaries, from which it appears that the fund amounts to nearly $2,300,000. The scale of salaries is to be as follows:

Instructors:	
Upon appointment	$1,200
Yearly increase	100
Maximum	1,500
Assistant Professors:	
In the first five-year term	2,500
In the second five-year term	3,000
Associate Professors:	
Upon appointment	3,500
Maximum	4,500
Professors:	
Upon appointment	4,000
Maximum	5,500

MRS. PHOEBE HEARST has presented to the California State University her archeological and anthropological collection from all parts of the world. It has cost over $400,000, and with it she presents to the university $60,000 for the maintenance of a department of anthropology.

HOPE COLLEGE, Holland, Mich., recently received $100,000 from Mr. Ralph Vorhees, of Clinton, N. J., $35,000 to be used in the erection of a woman's dormitory and the remainder to be added to the endowment fund.

A NEW chemistry hall has been erected for the University of North Carolina by a legislative appropriation of $50,000.

A BOARD of regents of the University of California has purchased the Bancroft Library. The purchase price was $250,000, of which amount H. H. Bancroft gave $100,000.

THE medical department of the University of Vermont, occupied for the first time, on

December 2, the building erected to replace the old structure, which was burned in 1904. The new building cost $100,000. The principal address at the opening exercises was delivered by Dr. John B. Grout, superintendent of the State Insane Hospital, at Waterbury.

Mrs. Clara C. Jacobus has given $25,000 to found a fellowship at Princeton University, to be conferred on the graduate student who has reached the highest excellence in his work during the previous year. An anonymous donor has given $10,000 to establish a fellowship in chemistry.

Mr. Henry B. Loomis of the class of '75 has given $10,000 to the Scientific School of Yale University to establish a fellowship in chemistry.

Mr. W. D. D. Crotch, M.A., of Asgard, Richmond, Surrey, bequeathed the residue of his personal estate after the termination of two life estates on trust for the museum of zoology at Cambridge, the interest to be set apart to form a fund for the purchase of books or specimens. The present value of the residuary estate has been ascertained to be about £8,000.

Lord Onslow, on November 18, opened the new museum and laboratories of zoology which have been erected at a cost of £18,000 in connection with the work of the University of Liverpool.

The library of the late John Stuart Mill has been presented to Somerville College for Women, Oxford, by Miss Helen Taylor. It contains about 2,500 volumes.

Mr. J. Martin White has offered to pay the expenses of a series of lectures in London University on Japanese education. With the aid of the Japanese minister at London, the university has completed arrangements with the Japanese government for the delivery of the lectures during the summer and autumn terms of 1906. The lecturer appointed by the Japanese government is Mr. Masataro Sawayanagi, director of the General Education Bureau in the Department of Education. He will probably deliver courses on the methods of Japanese home and school education, especially with reference to Japanese sociology, and also a course on Japanese methods of educational organization and administration.

The London *Times* states that in 1899 the Witwatersrand Council of Education raised a sum amounting to £100,000 for the purpose of providing elementary education for the Uitlander community. This money, which now amounts to about £115,000, has remained intact until the present time, with the exception of a portion of the interest which has been given to the Transvaal Technical Institute. At a meeting of the trustees it was decided to dispose of the fund in the following manner: £60,000 to the Technical Institute and £30,000 to found a public school at Frankenwald more or less on the lines of an English public school. The balance of £25,000 will probably be divided between Jeppestown High School and Johannesburg College, but is held over pending the report of the government commission on secondary education.

The graduate department of the University of Cincinnati has been reorganized with the title of graduate school. Its faculty consists of the heads of departments, with Professor Merrick Whitcomb of the department of history as chairman.

Nearly sixty students, who are members of the senior class in the Yale Forestry School, have left for the woods of northern Maine. They will spend the next two months in observing practical forestry and commercial lumbering work by the companies who conduct logging camps.

Dr. William Louis Poteat, formerly professor of zoology, was installed as president of Wake Forest College on December 7.

Mr. W. M. Barrows has been appointed Austin teaching fellow of zoology at Harvard University.

Dr. E. W. MacBride, Strathcona professor of zoology at McGill University, has been appointed examiner for the natural science tripos at Cambridge University.

Dr. W. A. Bowne, F.R.S., has been appointed professor of applied chemistry at the University of Leeds.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, DECEMBER 15, 1905.

CONTENTS.

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RESEMBLANCES AND DIFFERENCES AMONG AMERICAN UNIVERSITIES.[1]

THE American colleges and universities seem to the public and to their own constituencies to be very different; but as a matter of fact they are much alike, and what is more, they exhibit in a striking degree the same tendencies. In durable institutions tendency is quite as important as actual condition. It is my purpose in this lecture, first, to point out the fundamental similarities among the higher institutions of learning in the United States, and then to indicate briefly the nature and probable outcome of the differences they exhibit. (I ought to premise, however, that my remarks will have no application to the group of American institutions which derive from the Roman Church their form of government, their discipline and their program of studies. This firmly established group of colleges, which are chiefly under the control of the Society of Jesus, breathe the American atmosphere, and are not wholly inaccessible to the spirit of modern science; but being essentially ecclesiastical in structure and methods, they bear little resemblance to the ordinary

[1] An address given by President Eliot, of Harvard University, at Yale University, on November 15. Last year a graduate of Harvard University gave anonymously to Yale University a fund of $10,000, the income of which is to be devoted to the promotion of friendly relations between the two universities. The Yale authorities decided to appropriate the income for a series of lectures from representatives of Harvard University. President Eliot's address was the first of that series.

American college, which is historically Protestant in origin and development, and distinctly secular, though not irreligious.)

I.

The first likeness I wish to point out is the likeness in the constitutions of the bodies which own and govern the American institutions of higher education. At first sight these bodies seem unlike, and there are certainly many diversities among them; but there is a strong tendency toward the same constitution—a tendency which is due to like desires or objects, and to like experiences in the actual working of the bodies originally set up. When the general court of Massachusetts Bay created in 1642, by a natural inventive process, the first governing board for Harvard College, the act prescribed that it should be composed of the governor and deputy governor, the magistrates of the jurisdiction, and the teaching elders of six adjoining towns, with the president of the college. That is, the general court entrusted the infant college to a large group of the leading persons in the little colony. This same sort of thing has since been done all over the country. By skipping 225 years and 1,000 miles westward, I can take an illustration of this truth from the University of Illinois, which was established in 1867. This university was placed under the control of a board of trustees, consisting of the governor, the superintendent of public instruction, the president of the state board of agriculture and twenty-eight citizens appointed by the governor. The twenty-eight citizens appointed by the governor have since been changed to nine elective members; but the idea of the original structure was much the same as that underlying the first Harvard governing board, except that the churches had no representation as such. Going on to the Pacific, we find the University of California governed by a board of regents, seven of whom—including the president of the university—are *ex officio* regents and sixteen are long-term appointed regents, representing the various professions and business occupations, and to some extent the most important California communities. When Cornell University was incorporated in 1865 a very similar collection of men was set up as trustees, eight of them—including the president and librarian of the university—being *ex officio* members of the board, and the other thirty being leading representatives of the various professions and business occupations mostly within the state of New York. The original governing board of Yale University was composed exclusively of Congregational ministers, and remained in that condition for ninety-one years; but in 1772 there were added to this original board the governor, lieutenant-governor and six senior assistants in the council of Connecticut. These six senior assistants were subsequently changed to six senior senators. Thus, more than one hundred years ago the governing board of Yale University was brought into close resemblance to the original Harvard board. These few illustrations really cover all the essential varieties in the single boards of trustees.

Within eight years of the act that established the overseers of Harvard College the general court of Massachusetts established a smaller board under the title of the president and fellows of Harvard College, without repealing the act that had established the overseers of Harvard College. The new board consisted of but seven men, including the president and the treasurer of the university; and to this small board the general power of initiation and all money powers were committed, the overseers becoming a reviewing and examining body whose consent was required to important measures, but which had little power to

originate measures. Thus early Harvard University acquired the double-headed or bicameral organization that has proved invaluable in political constitutions, being in this respect the most fortunate of all the American institutions of learning. The same motives, however, which determined the general court of Massachusetts to charter the president and fellows of Harvard College have prevailed in all subsequent cases, though not expressed as at Harvard through the preferable method of establishing a separate governing board. The large body of trustees of an American college or university can not meet frequently. The members are too numerous, and their residences are so widely scattered that meetings are costly and troublesome. Moreover, they are too large for active executive functions. They have, therefore, as a rule, given large powers to an executive or prudential committee, the members of which can be conveniently brought together, and can give much time and thought to the affairs of the university. In this way many of the advantages of the bicameral organization of Harvard have been secured by the other American institutions. The initiating body is the executive committee, and the trustees inquire, examine and approve or consent.

The composition of the first Harvard governing board—the overseers—has been repeatedly altered by the legislature. The original composition was altered in 1780 to the governor, lieutenant-governor, council and senate of the commonwealth, with the president of Harvard College and the ministers of the Congregational churches of the six towns. Thirty years later the board was reconstituted as follows: The governor, lieutenant-governor, councilors, president of the senate and speaker of the house of representatives and the president of Harvard College, with fifteen ministers of Congregational churches and fifteen laymen elected by the ballots of the majority of the overseers. A few years later the senate of the commonwealth was incorporated in the board of overseers. In 1834 it was enacted that ministers of any denomination might be elected to the board of overseers. In 1851 the senate was dropped and the board was made up of the usual *ex officio* members and thirty persons elected by the senators and representatives of the commonwealth in six equal classes, each class to serve six years. Finally, in 1865, the power to elect these thirty overseers in six classes was conferred on persons who have received from the college the degree of bachelor of arts, or master of arts, or any honorary degree, voting on commencement day in the city of Cambridge. This series of changes in the Harvard board of overseers perfectly illustrates certain common tendencies in American institutions of the higher education which will ultimately bring them all to a great similarity so far as their governing bodies are concerned: in the first place, the amount of political control tends to diminish; secondly, the religious denominations lose influence; and thirdly, the graduates of an institution as such come into possession of some power over it. The state universities have steadily endeavored to diminish the influence of politics in the selection of their boards of trustees or regents; and they have also successfully excluded denominational control —not without effort, to be sure; for strangely enough, there was formerly a considerable amount of denominational control over some state universities, exhibited for the most part in the successive elections of presidents. Finally, many of the older American colleges and universities have succeeded in providing, sometimes by new legislation, and sometimes by tacit understandings, that a portion of the members of the single board of trustees shall be elected by the graduates of the

institution. Thus, ten of the trustees of Cornell University are elected by the alumni, and six of the members of the Yale corporation have been so elected since 1872, these six being graduates of the university. The tendency to exclude political considerations and influences from the government of all colleges and universities is strong, and will undoubtedly become effectual within a moderate number of years, with rare and temporary exceptions. The new Carnegie foundation, which provides pensions for teachers, except in institutions under denominational control, will help to induce institutions of learning to rid themselves completely of that control. It is so natural and proper to give some influence over the fortunes of a college or university to the body of its graduates, so soon as that body becomes large and strong, that the third tendency above mentioned is sure to be more and more exhibited. It can hardly come into full play, however, until the institution has been graduating young men for at least forty years.

II.

Another respect in which the American institutions of learning resemble each other is in the constitution and functions of the body of teachers called the faculty, and in the relations of that body to the governing board and to the students. In almost all cases the faculty has no legal powers, these powers residing in the governing board or boards, but is nevertheless entrusted with very important duties. It ordinarily has the control of terms of admission, of studies, of terms of graduation, and of rules of conduct. The teachers composing this body are paid salaries, which constitute their entire compensation, they deriving no income directly from the students. All American institutions are alike in this respect, and therein they all differ from most European institutions. At Oxford and Cambridge the tutor receives a fee for each student to whom he gives direct personal instruction, and the annual sum total of these fees may be larger than the highest salary of an American professor. At most continental universities a portion of the professor's income comes from the fees paid by the students who take his courses, and this portion of his income may be many fold larger than his fixed salary. There is no corresponding practise in the American institutions. The recent introduction of preceptors at Princeton University, inaccurately described in the newspapers as a copying of the English method, preserves the American custom that the college pays for all the instruction which the student receives —that is, the preceptors are to be paid fixed salaries, and are not to receive fees proportionate to the number of young men who take advantage of their instruction. This is a striking uniformity of practise in American institutions, which has grown up in a perfectly natural way through imitation of the earliest institutions, and because of the conformity of the practise to American needs and preferences.

The subjects of instruction which an American faculty will ordinarily deal with, unless the institution has very scanty means, are singularly uniform. Even a small and poor college will undertake to provide instruction in the classics and at least five modern languages, in mathematics, physics, chemistry, biology and geology, with some of their applications, and in history, political science, economics, sociology and philosophy. This list is much like the list of subjects that were to be taught in the University of Virginia, as declared in the act of the general assembly on January 25, 1819, except that Jefferson's list included the principles of agriculture, anatomy, medicine, the law of nature and nations, and municipal law, and was therefore much in advance of its time. It

should also be said that the University of Virginia contained in its eight independent schools of ancient languages, modern languages, mathematics, etc., the germ of the present organization of a university faculty into separate departments. There is now a large amount of consent as to the main topics a faculty of the liberal arts should teach; and the list is a decidedly comprehensive one. In all American institutions of any size the list includes many more subjects than any one student can pursue during the years of his residence.

The professors in an American institution are, as a rule, independent in their work, and themselves conduct the examinations in their several courses. They are not subject to outside bodies of examiners. Their instruction is not limited by the scope of an examination paper which another authority sets; and even the control of the faculty as a body over the work of an individual professor is so tenderly used as to be but rarely felt as a check on the individual teacher's will. The general assumption about the tenure of a professor is that his office is for life. Occasionally, in very new institutions, or in institutions over which political spoilsmen have won some control, exceptions to this rule come to the knowledge of the public; but the dismissal of professors is generally regarded by the public as evidence of an institution's inexperience, or of some temporary intrusion of forces or heats alien to the common university spirit.

The conduct of governing boards towards members of a faculty is generally marked by a high degree of respect and consideration; and great weight is attached to the faculty's advice on all matters lying within their recognized province. This is one of the reasons for the preference all American scholars exhibit for the service of colleges and universities rather than of public schools. Another reason for this preference is the departmental organization of instruction in all American colleges and universities. This organization began at Harvard College in 1766, and was then an invention of great novelty and interest. Previous to that time one tutor had given instruction in all subjects to the whole of a college class during the four years of its residence, a few lectures by the two or three professors being added to this large body of instruction given by one man. The departmental method in one hundred and forty years has spread all over the country, and has become universal in the institutions of higher education. It has also pretty well penetrated the secondary schools, and is on its way into the lower grades. Even during the last fifteen years the departments of instruction in the large universities, like Yale, Columbia and Cornell among the endowed institutions, and Michigan, Wisconsin and California among the state universities, have gained much in influence and power, because they have been organized better and better, and their membership has become more numerous and more united in the pursuit of common ends. At Harvard University the development of the department in merit and power as a working body has been one of the most striking internal improvements of the last ten years. A peculiarity of this development at Harvard has been that the chairman of a department is ordinarily changed every few years, and that in the choice seniority is not much regarded. Even an assistant professor may be chairman.

III.

An American faculty almost always feels a strong sense of responsibility for the conduct of their students, and give much thought to the effects of their teachings and rules and of the common academic life on the character of the student. Not every professor feels this responsibility; but

nevertheless a sense of duty towards the students in respect to the formation of character may be said to be characteristic of all the American faculties; and in this respect they all differ widely from similar bodies in Europe. The German professor, or the French professor, desires to impart to his students instruction and inspiration. He wishes to command their respect, rouse their ambition, and open their minds; but he seldom feels much responsibility for the conduct of university students. The old English universities inherited some monastic habits and a purpose to control the conduct of their students by physical means, such as requiring their habitual presence in chapel and dining hall at fixed hours, and the regular occupation of their chambers at night behind bars and gates; and to this day college buildings at Oxford and Cambridge are constructed with reference to these survivals of an antiquated discipline. The American college professor or instructor, in whatever part of the country he works, feels his responsibilities, but of course has none of the archaic English means and methods of exercising a physical control over his students. He trusts to example, to good traditions, and to that exhortation or guidance which rules supply, even when it is notorious that they can not be uniformly enforced. The faculty is generally reenforced in the exercise of their moral control by the public opinion of the alumni and by the *esprit de corps* of the students; but these supports are rather influences than forces. Hence the great importance in all the institutions of higher education, where large numbers of students congregate, of the transmissible spirit of the place, or the body of traditions handed down year by year from the older to the younger students. This spirit of the place is a compound of transmitted sentiments, manners and customs. There are numerous varieties of it; and yet the resemblances between the spirits, tempers or atmospheres of different institutions greatly exceed the differences. The sentiments nourished at all the American seats of learning are partially indicated by the few words which find place as mottoes on their seals, such as truth, light, learning, knowledge and training, labor, the people's safety and freedom through the truth. Baccalaureate and commencement addresses of exhortation, congratulation and hope are astonishingly alike at all the colleges and universities, for the reason that the institutions cherish the same aspirations and ideals. They are all ardent believers in the possibility of increasing human efficiency and happiness. When they study evils and abuses, it is in hope of discovering remedies or preventives. When they give much attention, as most of them have lately done, to studies in history, economics and government, they are looking for guidance to feasible reform and sound progress. The same altruistic spirit actuates them all.

The sense of responsibility for the conduct of the students and for the reputation of the university leads naturally to the devotion of an appreciable proportion of an American professor's time to matters of administration. The growing authority of the department as an organization has a similar tendency. The group of teachers that constitute a department are naturally ambitious to promote the study of their subject, to increase the amount of instruction offered by it, to improve the quality of that instruction, and to win for their department the increasing respect of the faculty and the students. They are always conferring with each other and with the older students for the promotion of these ends; and an appreciable proportion of their working time is spent in these administrative ways. The general welfare of the institution and its position among the neighboring or kindred institutions are sub-

jects of discussion in the faculty and its numerous committees; and these discussions take time and tax vitality. On many professors who are by nature attractive and sympathetic the students make exhausting demands for counsel and encouragement. The prosperous and progressive American institutions are all alike in expecting services of this nature from professors and other teachers, both old and young; so that the despatch of some administrative duties is a common part of the function of an American professor.

Another call often made on the American teacher is to create or care for collections, and to conduct the business of laboratories. These business-like functions are not unwelcome to professors who are fit for them. Indeed, some professors like these functions better than any others, and make themselves more useful in these directions than they could in any other; but, welcome or unwelcome, they fall to the lot of a large proportion of the higher teachers of a university, and take their time away not only from teaching but from research. To the creation and care of collections some of the most eminent American scientists gave a large proportion of their time, as, for example, Asa Gray, the botanist, and Louis Agassiz, the zoologist, at Harvard; James T. Dana, the geologist, and O. C. Marsh, the paleontologist, at Yale; James Hall, the geologist, at Albany; and Joseph Henry, the physicist, who was for thirty-two years secretary of the Smithsonian Institution at Washington. Innumerable lesser men have devoted to administrative work, or to libraries, collections and laboratories very significant portions of their total working time.

The governing bodies of American universities being generally composed of men not themselves experts in any of the university activities, the real direction of those activities devolves on the professors and other teachers; and there is no avoiding this delegation of power. For an American professor, or an American faculty as a whole, such questions as these are always open—how much administrative work shall fall to a professor? to what extent may administrative work, including museum work, be safely entrusted to special officials who are not teachers, but devote themselves almost exclusively to administration? and to what extent should scientific investigation and literary productiveness be made the function of men separated from the large class of university teachers, and expected to devote themselves to original research? Thus far, the expectation of all the American colleges and universities has been to combine these three functions—teaching, administration and research—or at least two of them, in the single person of the professor; and to-day this remains the commonest expectation, especially in the sciences, both pure and applied. Of late years the demand for men as professors who are capable of original research has been rising; that is, in selecting professors more account has lately been taken of proved capacity in this direction than used to be; but still there are very few positions in the United States where the prosecution of scientific investigation is made the chief business of a professor. In the thought of American college trustees, research and literary production are not separate functions, but accompaniments of teaching, to be maintained all the time, like bodily exercise, in connection with other stated occupations. The Germans have done more than any other people to create positions for investigators; and they have invented and put into force certain regulations for such positions which tend to secure the continuous activity of their incumbents. These regulations prescribe a moderate amount of public teaching by lectures or periodical reports, and the instruction and training of

some small number of assistants and advanced students who are frequently replaced. They really effect a combination of investigation with teaching, under the expectation that the greater part of the vital force of the professor will go to investigation. The triple function of the American professor and the American faculty illustrates perfectly the community of ideals in the institutions of higher education. American colleges and universities are unanimously of James Mill's opinion that to propagate the truth and to serve mankind are the only worthy objects of ambition, but with them to propagate means to seek, discover and bring forth truth, as well as to diffuse it. To accomplish these—the only worthy objects—requires direct teaching, conscientious administration, and eager research—all three.

IV.

All the American colleges have now adopted the elective system of studies, though not all to the same degree or extent. In general, a college or university teaches as many of the subjects for which there is a visible demand as the pecuniary resources of the institution permit; or, in other words, it maintains as broad an elective system as the number of teachers it is prepared to pay for can provide. There is, however, one other important limitation of the application of the elective system in the American colleges. Most of them receive their pupils from the secondary schools in such a condition that they feel obliged to devote one year, or even more, to studies appropriate to the secondary schools but not pursued there. They combine with these belated subjects a few of the most elementary subjects appropriate to colleges, and thus make up a prescribed freshman year, or, in some instances, a prescribed course for the freshman and sophomore years. This policy is, of course, a temporary one. It has already disappeared in some of the strongest institutions; and its complete disappearance in the American colleges and universities is only a question of time, for its evils are considerable. It reduces undesirably the number of years which the student can devote to the subject or subjects of his choice. It will make, for example, a great difference in the attainments of a young student of economics, or government, or physics, whether he can take a succession of courses, one or two at a time, in his chosen subject during four years, or three years, or only two years. The third or the fourth year given to advanced courses in his chosen subject is vastly more profitable than either of the underlying years. The ambition of departments, and their steady pursuit of their departmental interests, are sure to contribute powerfully to the remedy of this defect in the application of the elective system. Every department is always trying not only to increase the number of courses it offers, but also to prolong the series of courses which it offers in succession to persevering students. This departmental action tends to extend the instruction offered by the university, and to broaden and enrich the intellectual life of the institution. The advanced students who are attracted to a department which offers a long series of consecutive courses will contribute largely to make the university a place of research as well as of instruction. It is needless to remark that this expansion of advanced teaching is costly; it is worth all its costs.

Few people seem to understand how long and slow has been the growth of what is now called 'the elective system' in the American colleges and universities. It is eighty-one years since the University of Virginia was opened, with no general curriculum, the students selecting their classes or schools for each year. It is eighty years

since the beginnings of what is now the elective system appeared in Harvard College. It is more than sixty years since Francis Wayland published his 'Thoughts on the Collegiate System of the United States,' a work which led a few years later to the temporary adoption of a voluntary method at Brown University. For the first forty years of this long period the progress in liberty of choice for the student was slow; but for the last forty years it has been rapid, partly because of the great number of new subjects which have forced themselves on the attention of the educated public and the business world, and partly because the resources of the institutions of higher education in the United States have increased during the last half of this period very much more rapidly than they did during the first half.

In the long discussion of the effects of the elective system disproportionate attention has been given to the effect on the student of the liberty to select his studies from a large number of various courses. The most far-reaching effects of the elective system are its effects on the profession of teaching as a whole, and on national scholarship. Through the working of the system, the range of studies in the American universities, not for undergraduates only, but for graduates and professors, has been greatly widened. The standards of attainment for both teachers and taught have been much raised; intellectual efficiency has increased and the expectations and duties of the universities with regard to their own productiveness and influence have been exalted. The academic world of to-day hardly remembers the intellectual poverty of the American college of fifty years ago, when the entire amount of instruction offered by most colleges was the amount which a single student could absorb in four years—most of it being, of course, strictly elementary in quality, as well as thus closely limited in quantity. The titles of some of the older professorships in Harvard College indicate the expectation that one professor could occupy satisfactorily several large fields; thus, the professor on the Alford foundation, which dates from 1789, was expected to cover natural religion, moral philosophy and civil polity, and down to 1871 that small part of his time which this one professor could give to civil polity provided all the instruction there was in Harvard University in the subject of economics. The Hollis professorship of mathematics and natural philosophy was founded in 1727; and no other professorship of mathematics existed in the university for one hundred years, the one Hollis professor having charge of mathematics and of the entire subject which now goes under the general name of physics. There are still in the United States some colleges where the professors occupy not chairs but settees, as Dr. Oliver Wendell Holmes said of himself when he taught anatomy, physiology and microscopy; but these settees are fast falling to pieces. The change from a uniform prescribed curriculum, through which the college undertook to carry on to graduation almost all the young men who entered together in any given year, to a range of studies so wide that no two students need pursue precisely the same course between entrance and graduation has been very wholesome all over the country in another respect—it has made the college less an administrative machine for turning out an average routine product, and more a living fountain of individual scholarly interest and ambition.

V.

The large and strong universities in America are alike in their general purpose to provide good training for all the professions or intellectual occupations. It was two endowed institutions—Harvard and

Yale—that started scientific schools almost simultaneously in 1846–7; and this purpose characterizes the great endowed institutions to-day quite as strongly as it does the state universities. To this general proposition there is only one important exception; the state universities and many of the endowed institutions give no direct training for the ministry. For law, medicine, teaching, engineering of all sorts, mining, agriculture, manufacturing, the mechanic arts, and business, the American universities, so far as they discern the needs of the country, make the amplest provision which their resources permit. Several of them have lately added architecture to the list of their professional subjects. The training of professional musicians in a large sense has been taken up by a few universities. As soon as forestry was recognized as a needed profession in the United States, several universities began to provide instruction in that great subject. It is obviously the purpose of the American institutions of learning to train young men for all intellectual callings, making no distinction among them as regards their dignity and serviceableness.

The one exception in the case of the ministry has been made by the state authorities, because the states can not well admit single denominations to the control of theological instruction in their universities, and until recently undenominational theological instruction has not been recognized as a possibility. Many of the endowed institutions have so dreaded denominational control that they have preferred to omit altogether the department of divinity from their organization. Even institutions expressly created to spread a knowledge of the gospel and to prepare missionaries and schoolmasters, like Dartmouth College, for example, have omitted to establish a school or department of theology, preferring to send their graduates in search of theological training to special schools, or to other colleges which maintain a department of divinity. In this respect the case of Dartmouth College is particularly interesting, for it maintains a medical school, a school of science and the arts, a school of civil engineering and a school of administration and finance, but no school of theology.

The University of California very well illustrates the comprehensive purpose of American universities with regard to professional training. In addition to colleges of letters, of social science and of natural science, it maintains colleges of commerce, agriculture, mechanics, mining, civil engineering and chemistry, an institute of art, a college of law, a medical department, a dental department and a college of pharmacy. This purely state university is well matched by Cornell University on the other side of the country, a university governed by a board of trustees, and enriched by many private benefactions, but also by the bounty of the United States and the state of New York. This institution comprehends, in addition to the college of arts and sciences, a graduate department, the college of law, the medical college, the New York state veterinary college, the college of agriculture, the college of architecture, the college of civil engineering and the college of mechanical engineering and mechanic arts. It is clear, therefore, that the American universities intend not only to train men for the professions long called learned, but to 'promote the liberal and practical education of the industrial classes in the several pursuits and professions in life,' to quote the act of Congress approved July 2, 1862, granting to the several states public lands for educational purposes. Of course, many American colleges and universities are at present unable to furnish this great variety of professional instruction; but they all wish to do so, and all press that way as fast

as possible. It is also true that separate schools have been set up in many parts of the country to train young men for the technical and scientific professions; but in time these schools are likely to be transferred to neighboring universities, or to content themselves with training men for the lower grades of these professions, the universities all over the country being sure to appropriate the training of young men for the higher walks of the scientific professions and of business. The same forces which have carried the separate law schools and medical schools into the universities will carry the technical schools in the same direction, unless indeed these schools accept a lower function, like the training of foremen, draughtsmen, surveyors, assayers and the like. In respect to this comprehensiveness the American universities differ widely from the English Oxford and Cambridge, in which training for the professions has always had but a small place, unless indeed such preparation as these universities have long given for admission to orders in the Anglican church can by courtesy be called professional training. It is obvious that the policy of the American universities now under consideration has had, and is going to have, a strong effect to uplift the relatively new professions, like those of engineering, applied chemistry, architecture, music, mining, forestry, the public service, transportation and large scale manufacturing. These are highly intellectual occupations not yet universally recognized as on a level with divinity, law and medicine. The American universities will, in a few generations, put them all in their higher grades absolutely on a level with the older callings.

VI.

The American colleges and universities are alike again in their confident expectation of gratitude and support from their graduates; and the American public cordially sympathizes in this expectation on the part of the institutions and in the grateful and affectionate feelings of the graduates. For example, the public expects its own servants to exhibit a frank affection for the places of their education, and to show partiality for the graduates of their own particular institutions. It rather likes this partiality, as the natural result of youthful friendship and association. Every American institution of higher education counts on services to be rendered to it by its graduates, when they have come to places of influence and power, and esteems the success of its graduates in after life its own best asset, and its surest ground for public confidence and support. The endowed institutions rely on pecuniary support from most of their graduates who prosper in business or in the professions; and this reliance seems to be sound, in proportion to the age and merit of the respective institutions. The older they grow, and the greater their success in teaching and in scientific and literary production, the surer is their reliance on the disposition of the alumni to contribute substantially to the enlargement and improvement of their resources. This is one of the reasons that the American colleges and universities are so eager to train young men for the highest efficiency in all the professions and other intellectual occupations. Efficiency leads to success in all walks of life; and the success of its graduates is sure to contribute to the prestige and prosperity of any institution of the higher education, and to improve its material resources.

It is now time to consider briefly some of the differences among the American colleges and universities. It is certain that they have many strong and deep resemblances. What are their differences; and are they as well marked as the resemblances? The resemblances spring from a

similar historical development of policies and ideals; the differences are largely external, though not without importance. Thus, the sites of the American colleges and universities vary greatly in their natural beauty and their artificial surroundings. Some, like Columbia, Pennsylvania, Tulane and Chicago, have thoroughly urban sites, and those unlovely surroundings which are inevitable in the midst of a dense population. Others have suburban sites, capable of presenting some pleasant aspects of trees, shrubs and flowers, and lying within easy reach of the real country, or of public parks and forests. Others again are situated in small towns or villages where they possess considerable estates of their own, and are surrounded by the open country. These small college or university towns sometimes possess great natural beauties, such as hills, lakes or wooded glens near by, or mountains in the distance can give; while others have been placed on sites singularly devoid of natural beauty, or of interesting objects in their landscape. These differences of situation undoubtedly affect considerably the sentiments of the students towards their respective colleges, and in some degree the turn of their minds towards natural beauty. One can not but believe that such a prospect as that which the University of Virginia commands towards the Blue Ridge, or the University of California through the Golden Gate, must have a life-long effect on the mental habits and outlook of the young men and women who learn to love it. The ideal university ought to have a seat as beautiful as that of the Academy of Athens.

The American colleges and universities are situated in very different climates as regards summer heat, winter cold, dryness or dampness and exposure to malarial influences; and those most favorably situated for the promotion of health and hard work at all seasons of the year will doubtless prove to possess some permanent advantages over those whose situations are less desirable in this respect; but after all the main differences among these institutions as regards situation will in the long run be found to consist in their relative detachment or isolation from large concentrations of population. There will probably always be families or parents who think that young students should be separated from the temptations and distractions of city life, while other equally careful and conscientious people will think that music, the theater, the pleasant activities of polite society and the artistic interests which cities develop are essential accompaniments of the higher education.

The colleges differ widely in the use of dormitories, or halls of chambers, for the students. In an institution like Harvard or Yale, where these halls of chambers are numerous and large, the student life differs somewhat from the student life of a university like Michigan, where there are no such buildings; but the fraternity houses, which have become common in most of the American institutions, diminish considerably this difference in college life which results from the use or non-use of dormitories. The social student life in the different institutions is also affected by the homogeneousness, or heterogeneousness of the students. In most of the eastern institutions the students represent a great variety of family conditions. Some are rich men's sons, and some are poor men's sons; but the majority come from families that are neither rich nor poor. The breadwinners of the families follow an extraordinary variety of occupations. The eastern colleges in general—particularly those that are urban—have therefore had very heterogeneous bodies of students. On the other hand, some of the newer colleges and universities, situated in regions where agri-

culture is the principal occupation of the people, have remarkably homogeneous bodies of students, the fathers of the students being for the most part independent farmers, mechanics, and professional people who themselves live in the country, and are in moderate circumstances. This agreeable homogeneity tends, of course, to diminish, if strong differences of condition are developed among the population on the natural water-shed of the institution, or if the college site, once thoroughly rural, becomes citified through the advent of successful manufactures or of active trade.

There are certain more subtle differences between the American colleges, which it is easy to feel but hard to describe. Some of them have a characteristic tone, or common sentiment, towards some particular religious organization or institution, as for instance, towards the Protestant Episcopal, or the Congregational, or the Presbyterian, or the Methodist church; in some there is such an amount of agreement among teachers, graduates and students on some political dogma, like protection, for example, or bimetallism, or state rights, as to make rejection of that dogma a real difficulty for any discordant individual. Some exhibit a predominant interest in the applications of science; others maintain a strong interest in literature and history—an interest manifested in a striking degree by former generations of teachers and students at the same place, and also by eminent graduates. Others continue to exhibit an affectionate respect for some ethical or religious movement of former times. There is no doubt that the institutions of the north, the south, the east and the west respectively have somewhat different effects on the manners and bearing of their students, just as these students show slight common differences of voice and speech. These local differences are tolerably persistent; although there are now many American colleges to which students come from all parts of the country, bringing with them their own local manners, voices and pronunciations. In spite of these recognizable differences, it is to be observed that the American speech from Canada to the Gulf of Mexico, and from the Atlantic to the Pacific, presents no such strong local variations as little England presents, or as distinguish the north German from the south German.

There seems to be a considerable difference among the American colleges and universities in regard to charging a tuition fee; but this difference is really not so great or so important as it seems. To be sure, some of the state universities charge no tuition fee, while most of the endowed institutions charge a tuition fee varying from $50 to $200 a year; but it is to be observed, on the one hand, that many of the endowed institutions remit tuition fees with liberality, or possess numerous scholarship funds, the income of most of which is sufficient to meet the tuition fee and leave a balance applicable to board or lodging, and, on the other, that the state institutions have established the custom of charging various fees for entrance, incidentals, graduation and laboratory courses. Some of the state universities make a distinction between the college and the school of agriculture and mechanics arts, on the one hand, and the law school and medical school on the other, charging no tuition fee in the first group, but an ample tuition fee in the second. In the state institutions fees for some of the objects just mentioned are invariably collected; and the older the institution the larger these fees are apt to be. Thus, in the University of Michigan the matriculation fee is $10 for a citizen of Michigan and $25 for a person who comes from any other state or country; the fee for incidental expenses in the department of literature, science and the arts is $30 for Michigan students and $40 for all others; and in the

departments of engineering, medicine, law, pharmacy and dentistry this fee is $35 for Michigan students and $45 for all others. Fees are also required from all students who pursue laboratory courses; and in all departments there is a fee of $10 for graduation. The state universities which maintain summer sessions habitually charge a tuition fee for that session. At the University of Michigan this fee is $15 in the department of literature, science and arts. In the University of Illinois fees analogous to those of the University of Michigan are charged; and in addition there is a regular tuition fee of $50 a year in the college of law, and of $120 a year in the college of medicine. The state of California has been liberal to its university and to its schools, and tuition in the colleges at Berkeley is free to residents of the state; but non-residents of California are charged a tuition fee of $20 a year, and there is the usual charge for laboratory supplies, this charge amounting to from $5 to $30 a year. The law school has a fee of $10 a year for incidental expenses, and the medical department has a tuition fee of $150 a year, beside a matriculation fee, a graduation fee, and large fees for dissecting material, the rental of microscopes and laboratory breakage. When we consider, further, that the tuition fee, even where it is large, is seldom more than one third of the total cost of remaining one year in college, and that foregoing the productive labor of the boy is the real difficulty to be met by a poor family in sending a boy to college, we shall perceive that the varying amounts of the annual fees charged for tuition do not present a very serious difference among the American institutions of the higher education. Moreover, the tendency in the state institutions is to enlarge their annual fees under various names; and in the endowed institutions the tendency is to provide more and more scholarships and other aids for poor students, and to offer to competent undergraduates who need to support themselves during their college life better and better opportunities for earning money. Such opportunities are, of course, more easily procured in colleges situated in or near large cities. There they are so abundant that hundreds of young men go through these colleges chiefly on resources which they themselves earn, and graduate without having incurred debt. It is hard to do as much in an institution situated in a village or small town, even though no tuition fee be demanded of the student.

The American colleges and universities differ among themselves considerably in regard to admitting women to common residence and equal standing with men; but here again the differences are not as great as they at first sight appear to be, and they are diminishing. One may say, in a general way, that the leading eastern institutions are not coeducational, and that the leading western institutions are coeducational; but many of the eastern institutions, even those considered most conservative, are partially open to women, and others have entered into more or less intimate association with separate colleges for women placed in the same town or city. Among western endowed institutions there are several that have ceased to be thoroughly coeducational and have decided to segregate the women apart from the men. Leland Stanford Junior University, one of the newest and now one of the richest of American universities, has given notice that it will not, under any circumstances, admit more than a specified number of women. In the eastern part of the country the wholly separate college for women thrives, and gives evidence of present strength and increasing vitality. The probability is that, with the growth of educational resources and the increasing heterogeneousness of the population in the newer parts

of our country, the practises of the west will be assimilated to those of the east in regard to the education of young women with young men—that is, some institutions will remain frankly and throughout coeducational while others will detach the groups of women more or less from the groups of men, and others again will be coeducational in their graduate schools and summer sessions, but not elsewhere. Moreover, both separate colleges for women and colleges for women affiliated with universities for men will probably arise in the west.

A significant distinction among American colleges is based on their terms of admission, some requiring examinations, but the great majority admitting on certificates from secondary schools. Almost all the colleges use each method in some measure; but there is an important group of eastern colleges which admit regular students only on examination. Both methods have been improved and extended in recent years; so that there is now a good chance to test fairly the relative merits of the two methods. That method will ultimately be preferred by schools and colleges alike which delivers to the colleges the ablest, best trained, most ambitious and most efficient boys and girls. Between the two groups of colleges the decisive test will be the success of their graduates in after life. The differentiation among colleges on this basis may turn out to be quicker and more decisive than most experts have imagined, or on the other hand the results may be obscure and hard to demonstrate. Again, a third method, like that of Germany, may supersede both of the existing methods.

Another distinction among the leading universities of this country depends on the proportion which the work they do for undergraduates bears to the work they do for young men who already hold a bachelor's degree. The graduate schools in arts and sciences are increasing rapidly in number and in size; but the number of universities which require a bachelor's degree for admission to their other professional schools is still very small. Here again a sound experiment is in progress under fair conditions, and in ten years more it may be possible for judicious observers to determine what the interest of the universities is in this matter, and what the interest of the community. At any rate, it is certain that preparation for the professions is growing more and more elaborate, and that the influence of the professions steadily increases.

There is an important difference in the organization and management of the American institutions of higher education which has not attracted much public attention, but which really affects strongly the present management of these institutions and their future prospects. In many of the institutions, particularly the older and stronger ones, the president of the college or university is a member of the governing board, or boards, with the full powers of a member. In others, the board of trustees or regents elects its own chairman; and the president of the university, though invited to attend the meetings of the board, is not a member thereof, much less its head. The position of the president who is a member of the governing boards is, of course, stronger than that of a president who is not, provided that his personal quality and his experience are such as to give him influence with the boards. A board of trustees, which invites the presence of the president who is not a member by right, is inclined to look on the president as one of its numerous employees, with whose service they can dispense, if they like, as they would with the services of a professor, instructor or secretary. Such a relation to the governing board impairs the dignity and stability of a presidency, and there-

fore the influence of the incumbent. This is not a local or sectional difference in American universities. Some of the newer endowed institutions in the east have a president who is not a member of the governing board, while some of the state universities of the west have made the president invariably a full member of the board of regents. As the American institutions have grown, the function of the president has become more and more important to their prosperity and progress. In early times the president was the principal teacher. Down to the early part of the nineteenth century he was almost invariably a minister. In most of the larger institutions the president no longer teaches, and in many he is a layman. Common experience during the last fifty years teaches with certainty that the efficiency of any corporation—financial, manufacturing or commercial—depends on its having one responsible head who has knowledge of all its concerns, and gives guidance and inspiration in all its principal activities. A university corporation can not be an exception to this rule for securing efficiency. Again, the experience of the last fifty years teaches clearly that in all fields of human activity it is the trained expert who must invent and give direction. The president of a university must be either an expert himself in educational administration, or he must be a man who thoroughly understands how to utilize expert service. And thirdly, experience proves that long service gives accumulating value to well-selected officials; so that universities which give their presidents an honorable tenure, and get from them long service, will be likely to win great advantages over those who do not.

The American universities are obviously divisible into two groups, the endowed and the state supported, although the endowed may sometimes receive aid from government, and the state supported may possess some endowments. This difference in respect to the sources of their income, however, affects the policies and tendencies of the two groups much less than might be imagined. At present the leading endowed institutions are richer, and have larger annual budgets, than the leading state supported institutions; but, of course, this comparative condition may any year be reversed. It would be hard to prove that any important difference in discipline, educational policy, or scholarly ambition and aim, corresponds with or accompanies this division by sources of income. On the whole, the policies and aims of the two groups are extraordinarily similar. The division is not a strict geographical one. Most of the strong state universities are west of the Alleghenies, but in that vast region strong endowed institutions have also arisen, while in the south both groups exist side by side. California supports the state university of largest annual budget, and is also the seat of one of the richest of American endowed universities. The state universities are all young—Michigan not yet 70 years old, Wisconsin not yet 60, and Illinois, Minnesota and California not yet 40. Their future is very bright; but not brighter than that of the leading endowed institutions. The two sorts of university will both serve the country greatly, maintaining a fine rivalry in scholarship and in serviceableness, making common cause in promoting national intelligence, righteousness and efficiency, and illustrating the best results of the American passion for education. If, then, the American colleges and universities are strikingly similar, in spite of local and unessential differences, it is because they express and illustrate the fundamental convictions, beliefs and aspirations of the American people.

Charles W. Eliot.

SCIENTIFIC BOOKS.

RECENT BOOKS ON THE PHYSICS OF THE ELECTRON.

When it is remembered that the physics of the electron had no recognized existence prior to 1896, that it was 1898 before the corpuscular theory of cathode rays, carrying with it the possibility of the divisibility of the atom, had gained general acceptance, and that it was 1902 before the first book appeared which pretended to treat, in any systematic fashion, the new class of experiments which have to do with atomic ionization, or disintegration, one can not suppress his astonishment at the magnitude of the book literature which exists today upon the general subject of the electron theory. The greater part of this literature is of a popular character, consisting in attempts at the simplification and demathematicization of the technical books and articles which the investigators themselves, for the most part, write. For this reason there is often so great similarity of treatment that neither the busy scientist nor the busy layman can read it all with profit. In fact the bewildering frequency of the appearance of new, popular books in this field leads a reviewer in *Nature* savagely to remark that 'the time is fast coming when the qualification which will play the most important part in determining a man's reputation as a physicist will be that he shall abstain from writing books on the philosophy of ether, matter and the universe.' For my own part, I do not believe that the popular exposition of true scientific knowledge can be overdone. Hence, so long as the authors of new books are true to the scientific spirit, and shun the inviting paths of pseudo-science, I welcome each addition to their ranks. Since, however, the multiplication of books upon the same theme necessitates a choice, the present collective review of the book literature of the electron theory is undertaken with the object of presenting a brief characterization of the most important of these books, with a view of aiding the student of physics, whether he be trained or untrained, in selecting those books which best meet his immediate needs.

It need scarcely be said that the book which is the fountain-head of all electron theory is J. J. Thomson's 'Conduction of Electricity through Gases' (Macmillan, 1893, pp. 1–560). Coming as it does from the pen of the man to whose genius and inspiration more than to that of any other one individual, the physics of the electron owes its origin and its development, the book is as truly epoch-making as any other which has appeared for a hundred years. The student who is thoroughly familiar with its content, and who has also read the same author's somewhat more popular Silliman lectures on 'Electricity and Matter' (Scribners, 1904, pp. 1–162, recently translated into German) is in fairly good touch with the electron theory as it exists to date. It should, however, be said that the discussion of the theory in its relation to metallic conduction finds no place in either of these books and that a few facts have been brought to light since their publication, such, *e. g.*, as Boltwood's proof of the long-suspected relationship between radium and uranium, which have slightly modified certain minor aspects of the theory. The two books together are needed in order to put the reader into intimate contact with J. J. Thomson's views; the former in order to give him, in most convenient form, both a complete review of the experimental data upon which the electron theory rests and the mathematical analysis which it involves; and the latter in order to give him a clear idea, unbefogged by mathematical symbolisms, of the physical pictures, the naked mechanisms, so to speak, which are at the bottom of the author's theoretical investigations. Both books, I take it, are too profound and too technical to be intelligible to the student who has not had thorough training in physics and mathematics; although both, and particularly the latter, may be read with partial understanding, and, therefore, with a certain measure of profit, by workers in other fields of science. These are the two books from which the popular expositors of recent views, from Oliver Lodge down, have drawn the greater part of their material and inspiration.

The only other book the scope of which is as broad as 'The Conduction of Electricity

through Gases' is Johannes Stark's 'Die Elektrizität in Gasen' (Barth, 1902, Leipzig, pp. 1–509)—a book which might have vied in value to the physicist with Thomson's had it not been rendered well-nigh worthless for reference purposes by the slovenly, unscientific and thoroughly un-German way in which references to original articles have been inserted. Like Thomson's book, it covers the whole field of gaseous ionization, whether produced by Becquerel or Roentgen rays, by light, by heat or by electric fields. It exhibits immense reading and profound scholarship. It is, in fact, a magnificent compendium of all the facts of gaseous conduction known at date of writing; but, unfortunately, these facts are so badly mixed up with the author's inferences from them that it is in general quite impossible to tell what is fact and what is inference. It is of the utmost importance that a scientific book, and particularly a book covering a new and speculative field should accompany each statement of fact with a statement of authority as is so admirably done in both Thomson's and Rutherford's recent books. The bewildering mass of references to original articles which Stark gives in connection with each general division of his book is practically worthless, because it is obviously impossible to search through all of them in quest of the verification of some particular statement of fact. In a word, then, a book which, with a little more labor and a little better arrangement, might have been an authoritative reference book for the physicist in a new field, is, instead, an elaborate and, on the whole, decidedly dogmatic presentation of one man's interpretation of recent discoveries—an interpretation which is in many instances questionable, and in some instances certainly erroneous, notably in its relation to induced radio-activity, the stumbling-block of most of the continental physicists. It is, nevertheless, a suggestive and valuable book for the student whose reading and discernment are wide enough to enable him to take at their proper worth its ex-cathedra statements.

Turning now to books of more limited scope, but still books written primarily for the physicist rather than for the general public, Rutherford's inimitable work on 'Radio-activity' (Cambridge University Press, 1904, pp. 1–397, and presently to appear in enlarged and revised form) should unquestionably be given first place. Since it is to Rutherford that the credit for the discovery of the real nature of radioactivity is almost wholly due, the subject having been in a state of hopeless confusion till he brought order out of chaos, his book will probably always stand as the most important contribution which this branch of the physics of the electron will ever receive. Although the author reveals himself in it as the advocate of a theory, he, nevertheless, never jumbles fact and theory as Stark does. In immediate connection with every assertion of fact is found a reference by which the assertion may be checked. From the standpoint of the serious and trained student of radioactivity the book is well-nigh above criticism, for it gives: (1) complete and convenient references to the whole literature of the subject; (2) a clear account of the methods used in the study of the subject; (3) a *résumé* of all the facts discovered to date; (4) a clear discussion of all these facts in the light of the disintegration hypothesis. With suitable revision this book will doubtless long be regarded by the student of radio-activity as his dictionary of the subject. Furthermore, since mathematical processes play a much less prominent rôle than in Thomson's book, and since the style is particularly lucid and interesting, even the general reader will find both interest and profit in its perusal.

A fifth book which every physicist should take an hour or two to read is a small volume of sixty-two pages by H. A. Lorentz, just issued (1905) by Julius Springer in Berlin, and entitled 'Ergebnisse und Probleme der Electronentheorie.' It is a very unpretentious book, being only the publication of a lecture delivered before the Berlin Electrotechnical Society. It contains, however, the first attempt with which I am familiar at a semi-popular treatment of the electron theory in its relation to metallic conductors, a subject

which, on account of its mathematical difficulty no doubt, has thus far received but little attention in the book literature of the electron theory. This pamphlet will be welcomed by all because it gives one of the foremost of the world's investigators upon the mathematical side of the electron theory an opportunity to state the results of his work and to present the present status of the theory from the standpoint of the mathematical physicist.

The last of the books which I shall mention as coming from the hands of the pioneer architects of the structure which we now call the physics of the electron, is the work of the now famous discoverer of radium, Madame Curie. Her thesis, entitled 'Recherches sur les Substances Radioactives' (Gauthier-Villars, Paris, 1904, pp. 1–154), is a plain, conservative record of the history of this discovery and of the most important results obtained by both herself and others in the study of radio-activity. The book, unlike Rutherford's, is uninspired and unillumined by any deep insight into the real nature of the phenomenon under investigation, but it has the inimitable charm of a simple, direct history of one of the world's greatest discoveries told in charmingly modest fashion by the discoverer herself.

To turn now from the books which are primarily for the physicist to the popular expositions of the work of the investigators, there are none of them which do not require for their intelligent reading some elementary knowledge of physics; and if such a book were written it would be too superficial to be in any true sense scientific, for it would have to confine itself to *conclusions* rather than to a presentation of *reasons* for conclusions, and such statements of conclusions are almost invariably misunderstood. Among the books, however, which purport to be written for the general public there are two which show great ability and are characterized by striking individuality. The first place is claimed, in my judgment, by Hon. R. J. Strutt's fascinating, popular treatment of 'Becquerel Rays and the Properties of Radium' (Edwin Arnold, London, 1904, pp. 1–214). This is the book to which I should first refer the non-physicist who wishes to begin the study of the newer investigations which center about the physics of the electron. The author says that his aim has been to give as clear and simple an account of radio-activity as the subject admits of without sacrificing accuracy. He has, therefore, divorced himself entirely from all mathematical modes of statement. He has, nevertheless, succeeded, to a surprising degree, in giving, in simple language, a clear idea of the train of discovery and reasoning which has led to recent conclusions. In the truest sense we popularize science only in so far as we succeed in putting it in such form that the layman can understand, not our conclusion simply, but, in a general way, the reasons for our conclusions also. This Strutt has succeeded in doing. While his treatment is popular, it thoroughly vigorous, scholarly, accurate and conservative, so that it may be unhesitatingly recommended, not only to the general reader who wishes to gain a correct idea of the latest aspect of scientific thought in this domain, but also to the physicist who wishes to gain a clearer vision of the naked physical ideas which are at the bottom of, and sometimes more or less beclouded by, the mathematical presentation of the electron theory.

The other of the two books above referred to is Robert Kennedy Duncan's new work, entitled 'The New Knowledge' (A. S. Barnes and Co., 1905, pp. 1–257). It is a book which will generally be criticized by physicists, I think, as being, to use the author's own adjective, a trifle too 'enthusiastic'—too Jules Vernesque in its implications at least, if not in its statements, to be classed as strictly scientific; and I myself fear that the untrained reader will lay it down with a somewhat erroneous impression of 'the new knowledge'—an impression that a certain quiet evolution which has been going on for the last decade in scientific thought is, instead, a tremendous revolution; that new discoveries have overturned the cornerstones of the old faith. As a matter of fact, in popular presentation, too much emphasis can not be laid upon the fact

that, while our knowledge has been greatly extended in recent years, not a single established doctrine has been upset. The doctrine of the indivisible atom never existed even with Dalton, the father of the atomic theory. A belief in the ultimate possibility of the transmutation of some at least of the elements has been held as firmly by modern scientists, from Faraday down, as by ancient alchemists. Even the doctrine of the conservation of mass in the strictest sense has not been held since Maxwell's time. I am a bit sorry, therefore, that Mr. Duncan does not take more pains to point out that the new discoveries supplement and extend established doctrines instead of setting them aside, and I am particularly sorry that in a book intended for the general reader and purporting to popularize *existing scientific views,* a chapter like that on 'the reconstruction of the universe' should have been introduced. In this chapter, which to my mind, mars a book which is otherwise valuable, despite its enthusiasms, the impression is given that modern discoveries have led us to suspect that *perpetual motion* may still be possible. As a matter of fact, in the light of all recent discoveries, there is not one iota more of probability that the second law of thermodynamics is invalid than there was before any of these discoveries had been made. In spite of these criticisms, and in spite of the fact that throughout the book speculation often wears the air of certitude, I wish to recommend it heartily, not so much to the general reader, for whom it is intended, as to the scientist. Every investigator whose work in a narrow field has limited his outlook will find it immensely suggestive and inspiring. Its author shows himself to be a man of wide reading, thorough scholarship, broad horizon and unmistakable literary talent. I do not find in it one single incorrect statement of fact. The features which differentiate it from books of its kind are: (1) its remarkably fine treatment of the periodic law in its relation to the divisibility of the atom; (2) its popularization of J. J. Thomson's *Philosophical Magazine* article on the constitution of the atom, a difficult but very successful piece of work; (3) its presentation of the bearing of celestial phenomena upon the hypothesis of the evolution of the elements; (4) its statement of Arrhenius's views as to the effect of light, pressure and corpuscular emission upon comets' tails, aurora borealis and other allied phenomena; (5) its capital concluding chapter on the validity of the new knowledge.

The remaining books which deal with the physics of the electron may be briefly mentioned in the order of importance. Frederick Soddy's 'Radio-activity' (The Electrician Printing and Publishing Co., London, 1904, pp. 1–214) is an attractively and ably written book, the outline of which coincides closely with that of Rutherford's, from which it differs chiefly in that it is considerably more elementary and popular. To those who find Rutherford's book a trifle too difficult this will be distinctly helpful.

A. Righi's 'Modern Theory of Physical Phenomena' (translated from the Italian by A. Trowbridge, Macmillan, 1904, pp. 1–165) is a very unpretentious but thoroughly wholesome little book written for the purpose of popularizing for the Italians recent scientific work done mainly by Anglo-Saxons. It devotes a relatively larger space to the discussion of electrolysis and the Zeeman effect than do most of the other popular books of the briefer sort.

Paul Besson's little book, 'Le Radium et la Radioactivité' (Gauthier-Villars, Paris, 1904, pp. 1–166), is written by the man under whose direction the work of extracting radium from pitchblende for the Curies was done. It is the only book upon the subject with which I am familiar which is addressed especially to medical men. The earlier portion follows very closely the outline of Mme. Curie's book, of which it is in fact but an abridgment and simplification, while the last half is devoted to a statement of the uses which radium has found in therapeutics.

Baskerville's 'Radium and Radioactive Substances' (Williams, Brown and Earle, Philadelphia, 1905, pp. 1–161) covers about the field of the last book, but differs from it in presenting more of Rutherford's work and

in bringing the therapeutic applications of radium up to 1905 instead of 1904.

Jacques Danne's 'Das Radium: Seine Darstellung und seine Eigenschaften' (Veit and Co., Leipzig, 1904, pp. 1–84) is a little book which those who wish to familiarize themselves with the chemical side of the extraction of radium from its ores may well consult.

Hans Mayer's 'Die Neueren Strahlungen' (Papanschek, Mähr Ostran, 1904, pp. 1–65) is a rather unsuccessful attempt to present in elementary fashion the theory of cathode, canal, Roentgen and Becquerel rays. It is not characterized by the usual German scholarship, for while it shows wide reading on the part of its author, it contains unpardonable oversights and blunders.

R. A. MILLIKAN.

UNIVERSITY OF CHICAGO,
November 16, 1905.

Principles of Physiological Psychology. By WILHELM WUNDT. Translated from the Fifth German Edition (1902) by EDWARD BRADFORD TITCHENER. Vol. I. London, Sonnenschein; New York, Macmillan. 1904. Pp. xvi + 347.

One can not but admire the industry and courage of Professor Titchener, who, in the midst of an exceptional productiveness of original text-books, ventures also on a translation of so ponderous and difficult a treatise as that of Professor Wundt on physiological psychology. The labor involved and the difficulty of achieving an adequate English version of this important work are, indeed, enormous, as pointed out in a personally interesting preface by the translator. If only the translation is successful in combining the qualities of good English and faithfulness to the original, the undertaking is certainly meritorious and much to be welcomed by readers who are not disposed to cope with the author's German further than is necessary. And, to judge by the present volume, the translation does in fact fulfil these requirements. It is as readable as could be hoped; in fact it is probably easier reading than the original, even though the reader should possess equal facility in both languages. The only reservation to be made on this score is that, as the translator has adopted the Wilder nomenclature for the nervous structures, most readers will need to familiarize themselves with a good number of new technical terms. It impedes the reader's progress to meet 'myel' for the cord, and 'cinerea' for the gray matter. Probably in this matter the translator chose to be a prophet rather than easily read. As to the faithfulness of the translation, here the reviewer's part becomes a serious one. Without pretending, however, to have compared every page of the English with the original, the reviewer can state that he has examined in detail the translation of various difficult passages, and looked up instances where the English suggested a possible error, and after all found only a few little slips. One or two rather obvious errors in the original have passed over into the translation, *e. g.*, at page 286, where, quite in contradiction with the context, the brain-weight of a full-grown orang-utan is given as only 79.7 grams.

A curious error appears in Fig. 79 and in the accompanying text on page 187. It was transferred from the original, and was apparently not passed by the translator without question. The figure purports to show the connection of the retinas with the cerebral hemispheres, but errs in connecting the right half of each retina with the left hemisphere, etc.; the nerve fibers from the nasal half of each retina are stated to pass to the brain without crossing, while those from the temporal halves cross—just the reverse of the truth. As the figure is credited to Vialet, the reviewer looked up Vialet's original figure, and found a rather complicated drawing, which had been simplified by Wundt. In the process of simplification, Vialet's diagrams of the retinas dropped out altogether, and their place was taken by some diagrams of the monocular fields of vision which Vialet had placed in front of each eye to show the crossed relation obtaining between the field of view and the retina, due to the crossing of the rays of light within the eye. Wundt's confusion of the retinas and the fields of vision in the figure led him to reverse the true relations in the text. The error is rather amusing—espe-

cially since another diagram of the same thing (Fig. 99), occurring in a later chapter, is correct—and it is made more so by a 'later note by author,' in which Wundt, whose attention had apparently been called to the discrepancy, while not recognizing the perversion of the figure and text, endeavors to slur over the contradiction in a straddling manner that has a curiously characteristic sound. There are a number of other errors in neurological details, though not by any means a large number. Wundt would of course not be the author to whom one would resort for a knowledge of nervous anatomy and physiology, with which the present instalment of the translation is concerned. The value of this portion of the work lies in the author's broad, if somewhat speculative, views on the general principles of the structure and functions of the nervous system.

The translator has thoughtfully provided a special index for this volume.

R. S. WOODWORTH.

COLUMBIA UNIVERSITY.

SCIENTIFIC JOURNALS AND ARTICLES.

THE contents of *The Journal of Comparative Neurology and Psychology* for November is as follows:

CLARENCE LOEB: 'Some Cellular Changes in the Primary Optic Vesicles of Necturus.'

RAYMOND PEARL: 'Some Results of a Study of Variation and Correlation of Brain Weight.'

A. H. ROTH: 'The Relation Between the Occurrence of White Rami Fibers and the Spinal Accessory Nerve.' (With an Addendum by J. Playfair McMurrich.)

JOHN E. ROUSE: 'Respiration and Emotion in Pigeons.'

JOHN B. WATSON: 'The effect of the Bearing of Young upon the Body-Weight and the Weight of the Central Nervous System of the Female White Rat.'

The Work of Carl Wernicke.

H. S. JENNINGS: 'Papers on Reactions to Electricity in Unicellular Organisms.'

SOCIETIES AND ACADEMIES.

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES.

There will meet at New Orleans:

The American Association for the Advancement of Science.—The week beginning on December 28. Retiring president, Professor W. G. Farlow, Harvard University; president-elect, Professor C. M. Woodward, Washington University, St. Louis, Mo.; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Professor C. A. Waldo, Purdue University, Lafayette, Ind.; secretary of the council, Dr. John F. Hayford, U. S. Coast and Geodetic Survey, Washington, D. C.

Local Executive Committee.—Honorary president, President E. B. Craighead, Tulane University; executive president, Professor George E. Beyer, Tulane University; secretary, Henry M. Mayo, The New Orleans Progressive League; treasurer, Mr. Clarence F. Low, of the Liverpool, London and Globe Insurance Company.

Section A, Mathematics and Astronomy.—Vice-president, Dr. W. S. Eichelberger, U. S. Naval Observatory, Washington, D. C.; secretary, Professor L. G. Weld, University of Iowa, Iowa City, Iowa.

Section B, Physics.—Vice-president, Professor Henry Crew, Northwestern University, Evanston, Ill.; secretary, Professor Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Section C, Chemistry.—Vice-president, Professor Charles F. Mabery, Case School of Applied Science, Cleveland, Ohio; secretary, Professor Charles L. Parsons, New Hampshire College of Agriculture, Durham, N. H.

Section D, Mechanical Science and Engineering.—Vice-president, Professor F. W. McNair, Houghton, Mich.; secretary, Professor Wm. T. Magruder, Ohio State University, Columbus, Ohio.

Section E, Geology and Geography.—Vice-president, Professor Wm. North Rice, Wesleyan University, Middletown, Conn.; secretary, Dr. Edmund O. Hovey, American Museum of Natural History, New York, N. Y.

Section F, Zoology.—Vice-president, Professor Henry B. Ward, University of Nebraska, Lincoln, Nebr.; secretary, Professor C. Judson Herrick, Denison University, Granville, Ohio.

Section G, Botany.—Vice-president, Dr. Erwin F. Smith, U. S. Department of Agriculture, Washington, D. C.; secretary, Professor F. E. Lloyd, Teachers College, Columbia University, New York, N. Y.

Section H, Anthropology.—Vice-president, Dr. George Grant MacCurdy, Yale University, New Haven, Conn.; secretary, George H. Pepper, American Museum of Natural History.

Section I, Social and Economic Science.—Professor Irving Fisher, Yale University, New Haven, Conn.; secretary, Dr. J. F. Crowell, Bureau of Statistics, Washington, D. C.

Section K, Physiology and Experimental Medicine.—Vice-president, Professor Wm. T. Sedgwick, Massachusetts Institute of Technology, Boston, Mass.; secretary, Dr. Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

At New Orleans in conjunction with the American Association for the Advancement of Science there will meet:

The American Chemical Society.—President, F. P. Venable, University of North Carolina; secretary, Dr. William A. Noyes, the Bureau of Standards, Washington, D. C.

The Botanical Society of America.—January 4. President, Professor R. A. Harper, University of Wisconsin; secretary, Dr. D. T. MacDougal, N. Y. Botanical Garden, Bronx Park, New York City.

The Association of Economic Entomologists.—January 1, 2, 3. President, Professor H. Garman, Lexington, Ky.; secretary, Professor H. E. Summers, Ames, Iowa.

The American Mycological Society.—January 1–4. President, Chas. H. Peck, state botanist, Albany, N. Y.; secretary, C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

At Ann Arbor will meet:

The American Society of Naturalists.—President, Professor William James, Harvard University; secretary, Professor W. E. Castle, Harvard University. President (Central Branch), Professor H. H. Donaldson, University of Chicago; secretary, Professor W. J. Moenkhaus, Indiana University. The Eastern Branch will not meet this year.

The American Society of Zoologists (Eastern and Central Branches).—December 28, 29, 30. President (Eastern Branch), Professor W. E. Castle, Harvard University; secretary, Professor H. S. Pratt, Haverford College. President (Central Branch), Professor Frank R. Lillie, University of Chicago; secretary, Professor C. E. McClung, University of Kansas.

The Society of American Bacteriologists.—December 28, 29, President, Professor Edwin O. Jordan, University of Chicago; secretary Professor Frederic P. Gorham, Brown University, Providence, R. I.

The American Physiological Society.—December 27, 28. President, Professor W. H. Howell, the Johns Hopkins University; secretary, Professor Lafayette B. Mendel, New Haven.

The Association of American Anatomists.—December 27, 28, 29. President, Professor Charles S. Minot, Harvard Medical School; secretary, Professor G. Carl Huber, 333 East Ann St., Ann Arbor, Mich.

The Society for Plant Morphology and Physiology.—December 27, 28, 29. President, Professor E. C. Jeffrey, Harvard University; secretary, Professor W. F. Ganong, Smith College, Northampton, Mass.

At New York City will meet:

The Astronomical and Astrophysical Society of America.—December 28. President, Professor Simon Newcomb; secretary, Professor Geo. C. Comstock, Washburn Observatory, Madison, Wis.

The American Physical Society.—December 29, 30. President, Professor Carl Barus, Brown University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Mathematical Society.—December 28, 29. President, Professor W. F. Osgood, Harvard University; secretary, Professor F. N. Cole, Columbia University.

At Cambridge will meet:

The American Psychological Association.—December 27–29. President, Professor Mary Whiton Calkins, Wellesley College; secretary, Professor Wm. Harper Davis, Lehigh University.

The American Philosophical Association.—December 27–29. President, Professor John Dewey, Columbia University; secretary, Professor John Grier Hibben, Princeton University.

At Ithaca will meet:

The American Anthropological Association.—December 27–29. President, Professor F. W. Putnam, Harvard University; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

At Ottawa will meet:

The Geological Society of America.—December 27, 28, 29. President, Professor Raphael Pumpelly; secretary, Professor Herman L. Fairchild, Rochester, N. Y.

THE ASSOCIATION OF TEACHERS OF MATHEMATICS.

THE annual meeting of the Association of Teachers of Mathematics in the Middle States and Maryland was held on Saturday, December 2, in affiliation with the Association of Colleges and Preparatory Schools of the Middle States and Maryland.

The following papers were presented:

PROFESSOR H. S. WHITE, Vassar College: 'How should the College Teach Analytic Geometry.'

Mr. H. R. Higly, Pennsylvania College: 'Suggestions for the First Twelve Lessons in Demonstrative Geometry.'

Dr. John S. French, Jacob Tome Institute, Port Deposit: 'Some Essentials of the Successful Mathematics Teacher.'

Dr. H. A. Converse, Baltimore Polytechnic Institute: 'The Teaching of Geometry.'

The association was disappointed at not being able to listen to a paper on 'The Teaching of Pure and Applied Mathematics,' which the program announced was to be read by President R. S. Woodward, of the Carnegie Institution, Washington.

The following officers were elected for the coming year:

President—Professor E. S. Crawley, University of Pennsylvania.

Vice-President—Dr. John S. French, Jacob Tome Institute, Port Deposit, Md.

Secretary and Treasurer—Dr. J. T. Rorer, Central High School, Philadelphia, Pa.

Members of the Council—Professor W. H. Metzler, Syracuse University; Miss L. G. Simons, New York City Normal College; Dr. J. L. Patterson, Chestnut Hill Academy, Philadelphia, Pa.; Professor W. H. Maltbie, Woman's College of Baltimore.

At the meeting the following resolution was adopted:

Resolved: That this association approve of the organization of a national federation of existing associations of teachers of mathematics in which each association shall preserve its own organization and individuality and which shall have among its objects the joint support of publication. In the federation should be included only societies representing territory as extensive at least as one state.

DISCUSSION AND CORRESPONDENCE.

THE RELATIONS OF MUSEUMS TO EXPERTS AND SYSTEMATISTS WHO ARE ENGAGED IN WORKING UP AND NAMING COLLECTIONS.

From time to time the writer has met those who have maintained the view that a scientific expert is entitled out of collections, whether submitted to him by individuals or by museums, to retain for his own use whatever portion of such collections he may desire to reserve for himself, after having described them. Some years ago a rather well-known entomologist in correspondence laid down the proposition that 'it is the unwritten but universal law that an expert to whom scientific material is submitted for study is entitled to retain therefrom anything he pleases,' and further added the statement that 'it is the indefeasible right of an expert to retain for his own use anything which he may wish to reserve out of the collections submitted to him for study.' These statements being wholly contrary to the teachings of his own experience and observation, the writer was moved to address a circular letter of inquiry to a large number of the most eminent scientific men charged with the administration of the affairs of museums in America and in Europe, inquiring whether they knew of the existence of any such 'unwritten law' or recognized any such 'indefeasible right' on the part of experts to whom they might entrust material for study. The persons to whom this circular letter was addressed are men who stand in the very foremost ranks of science, among them the heads of the greatest museums in Europe and America, and a score of the most eminent investigators along biological lines now living.

The writer received not merely a series of replies upon the blanks provided in the circular letter for answers, but in a number of cases lengthy and interesting letters, which showed that some of the gentlemen addressed had encountered those who held this view, which they reprobated as strongly as does the writer himself. Others expressed unmitigated astonishment that any one should have the temerity to propound such propositions, declaring them to be altogether unheard of and monstrous. Answers were received from forty-four gentlemen in America, who are recognized as the highest authorities in their respective lines of research. Only three of these appeared to claim that usage demands that the expert should be allowed to retain for his own use what he may desire. Two of these were entomologists; one was a botanist. The others most unqualifiedly denied the truth of the propositions and treated them as ridiculous. Twenty replies were received from the

most eminent scientific men of Great Britain. Only one of the number declared the view of my correspondent to be in his judgment correct. The other nineteen utterly reprobated his propositions, declaring them to be in their judgment wholly untenable. Sixteen of the leading scientific men on the continent of Europe replied, all of them rejecting the propositions as unheard of, and contrary to all experience and usage.

It appears from the eighty replies received by the writer that only four, or five per cent., of those whom he addressed, three of these being Americans, had ever heard of the propositions laid down by his correspondent, and the rest all reprobated the doctrine.

What then is the attitude which should be taken by a museum toward the expert who is requested to work up scientific material in the custody of an institution? That he has the right to endeavor to enrich his own collections, if he happens to be a collector, at the expense of the collections submitted to him for study, I think will be almost universally disallowed. That he should, however, be recompensed for his labors, if he desires to be recompensed in any other way than by the pleasure and honor he may derive from being permitted to write upon the material entrusted to him, will be conceded. In case an expert desires a financial return for his service in the way of a *honorarium,* to grant this in accordance with the ability of the institution seems to the writer to be eminently proper. Furthermore, if he desires to retain for his own use and for aid in future study *duplicate material* where such duplicate material exists, it is the opinion of the writer that he should be allowed to do so, and in fact it may be said that it is the almost universal custom to allow experts to retain a reasonable amount of duplicate specimens from collections where such duplicates exist. But *all types of species and genera* based upon collections which are submitted to experts *should be invariably returned* to the owner of the collection, unless a previous arrangement to the contrary has been made. And this is particularly true in the case of the collections of great museums, which are founded for the purpose of recording and preserving for future generations the results of scientific research. The writer has had considerable experience in this matter and has never felt himself at liberty, when called upon to study and examine collections other than his own, to do more than to suggest to those who have had the kindness to submit them to him for examination that he would be pleased in case duplicates existed in the collection to be allowed to retain of this duplicate material sufficient to enable him in coming time to work to greater advantage.

The museums of the country should be cautioned against dealing with any individual who holds the view to which the writer has called attention, and as the head of one of the greater museums of America the writer desires to say that the authorities of this institution will never consent to allow any portions of the collections in their custody to pass out of their keeping into the hands of those who may wish to study them without having, preliminary to such act, reached a clear and distinct understanding to the effect that all types shall be returned to the museum, and that only duplicate material shall be allowed to remain in the possession of the expert, the amount of such duplicate material which is to be granted to be determined by the authorities of the museum themselves. This is in the judgment of the writer correct usage. He knows, however, that there are a dozen or more men of more or less reputation in scientific circles who hold the opposite view. He believes, however, that they are in a hopeless minority, and that their opinion in the matter is unsound from the standpoint both of science and of good morals.

W. J. HOLLAND.

CARNEGIE MUSEUM,
PITTSBURG, PA.

A LECTURE EXPERIMENT IN HYDRAULICS.

TO THE EDITOR OF SCIENCE: The phenomenon of the diminution of pressure in a contracted portion of a water pipe, as exemplified by the so-called jet pump and by the Venturi water meter, always seems paradoxical to the student in physics, and it is important, there-

fore, to bring out the phenomenon in such a way as to divest it of its paradoxical features. Perhaps the most insinuatingly paradoxical aspect of the phenomenon is that which is

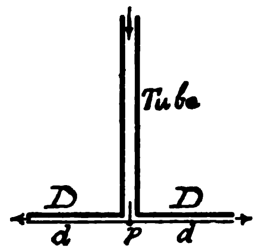


Fig. 1.

presented by the well-known toy which consists of a flat metal disk *DD*, Fig. 1, at the end of a metal tube and a light metal disk *dd*, which is hindered from moving sidewise by a pin *p* which projects into the tube. Blowing through the tube causes the disk *dd* to be held tightly against the disk *DD*.

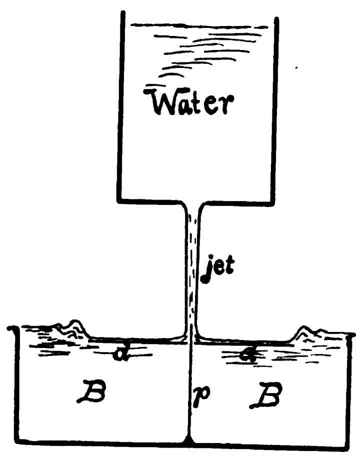


Fig. 2.

Fig. 2 shows an arrangement in which all of the essential actions which enter into the behavior of Fig. 1 are reproduced in a more easily intelligible form. A light metal disk *dd* is prevented from moving sidewise by a pin *p*, and a jet of water impinging upon the center of the disk *dd* causes it to float. The thin stream of water which moves radially outwards over the surface of the disk maintains a wall of water around the edge of the disk, and the disk floats very much as if it were a shallow pan with a metal rim. Over the surface of the disk the thin stream of water has a high velocity and a low level (pressure) and at the edge it raises itself to a higher level (pressure) as it loses its velocity. So, in the case of the apparatus shown in Fig. 1, the thin stream of air between the two disks has a high velocity and a low pressure and at the edge of the disks it raises itself to a higher pressure (atmospheric pressure) as it loses its velocity. Evidently, then, the air between the disks *dd* and *DD* of Fig. 1 is at a lower pressure than the outside air and the difference in pressure operates to hold the disks together. W. S. Franklin.

THE FIRST DISCOVERY OF FOSSIL SEALS IN AMERICA.

To the Editor of Science: While engaged in collecting fossils for the National Museum from the northern range of the Calvert Cliffs, on the west shore of Chesapeake Bay, Maryland, during the summer and fall of 1905, I had the good fortune to find bones of true seals, which are, so far as I am aware, the first authentic remains of American fossil seals. As the Calvert Cliffs are entirely Miocene at their northern end, these bones can safely be assigned to that geological period. They will be described later in the *Proceedings* of the National Museum.

Remains from several localities in the United States, supposed to be those of seals, have been described or alluded to by Leidy and other writers, but, as shown by Dr. Allen's careful review, they are all of doubtful authenticity, 'not a single extinct species having been certainly determined.' F. W. True.

U. S. National Museum,
Washington, D. C.,
November 23, 1905.

A BLAZING BEACH.

In the early part of September the papers throughout the country gave wide publicity to the occurrence of a phenomenon at Kittery Point, Me., which attracted much local consideration because of its sensational aspects, and which might be correctly described as a

'blazing beach.' On the evening of Friday, September 1, the guests at the Hotel Parkfield were startled by the appearance of flames rising from the beach and from the surface of the water, an event of so remarkable and unusual a character as to excite great curiosity and some alarm. The conflagration occurred between seven and eight o'clock in the evening, and lasted for upwards of forty-five minutes. The flames were about one foot in height. They were accompanied by a loud and continuous crackling noise which could be distinctly heard one hundred yards away, while at the same time there was a very strong liberation of sulphurous acid fumes which penetrated the hotel, drove the proprietor and his staff from the office and filled the other rooms to such an extent as to cause great inconvenience to the guests. One guest of an investigating turn of mind secured some of the sand in his hand, but was obliged to drop it on account of the heat. When some of the sand was taken into the hotel and stirred in water, bubbles of gas were liberated and produced flame as they broke at the surface in contact with the air.

Some of the attempts at explanation were of a remarkable character and illustrate how far one may be carried when the imagination is not controlled by an adequate knowledge of facts. One observer stated that some vessel in the harbor had thrown overboard a quantity of calcium carbide which had washed ashore and caught fire. The most popular explanations referred the phenomenon to the effects of the blast at Henderson's Point, some six weeks before, the theory being that the explosion of fifty tons of dynamite had opened up rock fissures to such an extent as to liberate volcanic gases; while a somewhat similar theory attributed it to the earthquake of the day before, and the consequent opening up of rock fissures. With respect to the latter it may suffice to state that the earthquake may have been a contributary factor in so far as it served to give just that shaking at a critical moment which would suffice to liberate gases stored under slight pressure. The most sensational explanation was that of a resident of the town who refused to accept the explanation I offered as altogether too commonplace, and who had 'always told the people of Kittery Point that the town was built on the edge of hell, the proof of which had now been given.'

Divesting the phenomenon of its sensational aspects, it was not difficult to reach a satisfactory explanation of all the features presented, and to eliminate explanations which had some semblance of reasonableness. The beach at the point where the fire occurred is composed of a beach ridge at its upper margin, made up of pebbles of varying size. From this ridge, a somewhat sharp slope continues the same formation outward and downward for perhaps seventy-five feet, where the pebbles are replaced by sand. This latter begins at about the half-tide mark and extends outward with a very gentle slope beyond low-water mark, so that during even the lowest tides a portion is covered by very shallow water. This sand beach extends laterally for a distance of about 175 to 200 feet, being limited in each direction by solid ledge, which forms the general construction of the shore all along the river. Over the outer portion of the sand, as also for great distances beyond, wherever there is a muddy bottom, there is an abundant growth of eel grass (*Zostera marina*) which, together with other debris of a similar nature, is continually washed upon the beach, broken up by the action of the waves and gradually buried, so that each year the deposit is increased by definite though rather slight increments. One of the well-defined features of the fire was, that it was limited to that area which is occupied by the sand. It occurred over that portion of the sand which was exposed by the falling tide, but it was also observed to extend out over the water for a distance of thirty or forty feet. Gas was found to be liberated from the exposed sand when stirred in water, and similarly gas was seen to rise from that portion of the sand covered with water. Such facts showed conclusively that the evolution of the gas was immediately connected with the sand itself and not with the adjacent rock formation, hence the theory

that rock fissures had been opened could not be regarded as resting upon a valid basis.

Observation has shown that in the salt marsh lands of the coast the underlying portions of the sod are continually undergoing decay with the formation of large quantities of sulphuretted hydrogen, with which there must also be associated certain amounts of the light carburetted and possibly also of the phosphuretted hydrogen. Personal experience has shown that such gases are stored in the decaying turf in large quantities, being often held in pockets, so that when the turf is cut they may escape in such volume as to drive one away for the time. It is also known that any decaying vegetation will produce similar results, and two explanations were, therefore, suggested as offering a solution of the problem: (1) that there was an area of buried marsh such as is known to exist in places along the coast, and that its decay had given rise to combustible gases; (2) that the accumulations of organic debris in the formation of the beach had been productive of the results observed.

That one or both of these causes would offer an adequate explanation was adopted as a tentative hypothesis, and an examination of the beach was proceeded with. It was found that the superficial layer to a depth of about one inch, consisted of freshly washed sand with which there were mingled fragments of marine plants and even fragments of land plants. Successive accumulations are thus transferred from the superficial layer to that below, which was found to be about six inches in thickness, and to consist of sand filled with all sorts of organic debris, including marine plants, fragments of wood and bones. Moreover, this layer was perfectly black, and when washed it exhibited very small, carbonized fragments of zostera and other marine plants, fragments of wood with a distinct surface charring, and bones of animals, the surface of which was like ebony. Below this layer there was a deposit of beach pebbles mingled with sand, and as this formation continued to the limits which it was possible to reach with the implements at hand—about two feet—the conclusion was reached that such was the lower construction of the beach and that no buried marsh was present. This naturally led to the final conclusion that the six-inch layer, rich in organic matter, was entirely responsible for the production of inflammable gases which had been accumulated there until favorable conditions for their release were presented.

An explanation of the spontaneous combustion of these gases is not difficult. The light carburetted and the phosphuretted hydrogen are well known to ignite spontaneously wherever produced in marsh lands, thus giving rise to the well-known 'will-o'-the-wisp,' 'Jack-o'-lantern' and the ignis fatuus, 'corpse candle,' etc., which are well known to the folk-lore of England. That sulphuretted hydrogen was also present has been abundantly shown, and since this would naturally be set on fire by the other gases, it is possible to reach a complete explanation of a phenomenon which must have occurred at more or less frequent intervals in the past, though escaping observation through lack of combination in those circumstances which would bring it under direct notice. It would seem, however, that the possibility of such combustion on a rather large scale offers a most reasonable explanation of many forest fires, the origin of which it has hitherto been impossible to account for in a satisfactory manner.

D. P. PENHALLOW.

BOTANICAL LABORATORY,
McGILL UNIVERSITY,
November 17, 1905.

'THE COLLAPSE OF EVOLUTION.'

TO THE EDITOR OF SCIENCE: One of your correspondents, two months or so ago, sent you an outline of an argument against the doctrine of evolution delivered as an address by Rev. L. T. Townsend, professor emeritus in the theological department of Boston University. The paper may now be had as a separate.[1] This pamphlet contains so much in the way of new and surprising information, that it is

[1] Bible League, Credo Series, No. 2, National Magazine Co., Boston and American Bible League, 82 Bible House, N. Y.

clearly 'one of the books which no [scientific] gentleman's library should be without.'

The theory of evolution being now, as Professor Townsend informs us, 'discredited and abandoned by the best scholarship of the world,' it is high time that the 'American university professors' who still continue to deceive the people on this important question, should be called to account. "Were these professors clergymen, would it be discourteous to characterize such an exhibition as a piece of superb ignorance or insolence?" 'We are a little behind the times on these questions in this country as compared with England, France and Germany, though ahead in almost everything else'; and 'the most thorough scholars, the world's ablest philosophers and scientists, with few exceptions, are not supporters, but assailants of evolution,' so that American men of science will do well to heed this clarion call from Boston University. "If these facts as to the attitude of leading scientists, and if this revolution of opinion in Germany are known, and certainly they ought to be, then can the silence of our American evolutionists be looked upon as honest or manly?"

The trouble with us over here in the wilds of North America is that we have been making fine-spun distinction where there is no real unlikeness. "What essential or fundamental difference is there between Darwinism and any scheme of evolution that may be or can be proposed?" Professor Townsend repudiates with scorn the suggestion that he confuses evolution and Darwinism. They are the same thing; and every naturalist who questions the all-sufficiency of selection becomes *ipso facto* an advocate of special creation. De Vries, among others, has his name called right out in meeting on the strength of that eminent scientific authority, the *Literary Digest.*

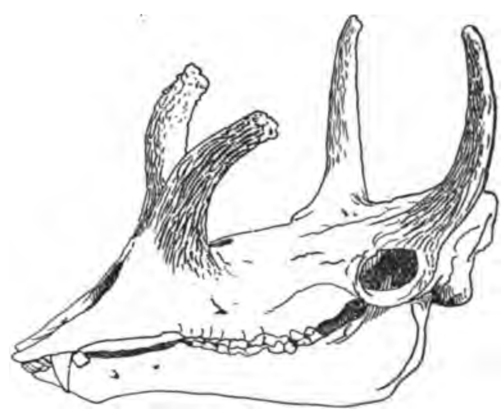
A muddle-headed chap the evolutionist—or the Darwinian—is at best: see how he gets fooled by the Tertiary horse! "While there is some resemblance between these four-toed animals and the modern horse, as there are some resemblances between a cow and a crow, a man and a mouse, each having a head with its eyes, nose and ears, and each having feet with which to walk, yet these resemblances furnish no more evidence of organic connections and transmutations in the one case than in the other—that is no evidence at all." But then what is to be expected of persons who employ "such terms as 'bathiosm,' 'cosmic ether,' 'cosmic emotion,' 'germplasm,' 'pangenesis,' 'protoplasm,' 'growth force,' 'vital fluid,' and the like. * * * It should be said, however, that not for five or ten years have these terms, once potent on the lips of scientists and philosophers, been employed seriously by any reputable writer on these subjects."

After this warning, if any reader of SCIENCE is caught saying 'protoplasm,' it will be his own fault! E. T. BREWSTER.

SPECIAL ARTICLES.

A NEW MIOCENE ARTIODACTYL.

AMONG several discoveries made in the Daimonelix beds (Loup Fork) of Sioux County, Nebraska, the most striking one of the season seems to be that of a new four-horned ancestral antelope, *Syndyoceras cooki*, the skull of which is herein figured and briefly described. The discovery was made by Mr.



Syndyoceras cooki, Barbour, 1905.

Harold G. Cook, a former Lincoln student and a member of the Morrill geological expedition of 1905.

The specimen, which gives promise of being complete, was found on the west bank of the Niobrara River in the bluffs bordering the extensive ranch of Mr. James Cook, Agate,

Nebr. The skeletal parts known at present are the skull and mandible; the vertebral series, complete as far as exposed, and articulated; the pelvis and sacrum and the hind limbs complete and likewise articulated; several ribs attached to the vertebræ above and to the sternum below, and a portion of one scapula. The fore limbs are not yet in evidence, but will doubtless be found either in the material collected or else in the quarry, which still showed numerous bones when work was suspended.

The most striking characteristic of the skull is the four prominent horns, of which the frontal pair rises upward and curves inward, while the maxillary pair curves in the opposite direction. The maxillary horns, uniting as they do at the base to form a common trunk, divide the anterior nares into two portions, the posterior of which may or may not have been functional. However this may have been, the margin of the opening seems to have been roughened as though for ligamentous attachment. The dentition is complete, though, consequent to age, the teeth are worn. The premaxillæ are edentulous. The upper canines, which are strong and defensive, curve noticeably outward. The lower canines have migrated and assumed an incisiform function, while the first premolars have in a like manner become caniniform. Dentition:

$$\text{I. } \tfrac{0}{3},\quad \text{C. } \tfrac{1}{1},\quad \text{P. } \tfrac{3}{4},\quad \text{M. } \tfrac{3}{3}.$$

Measurements of the skull: Length of skull, $12\frac{3}{4}$ inches (325 mm.); distance between the orbits across the frontals, 5 inches (128 mm.); height of anterior horn cores above plane of molars $6\frac{1}{2}$ inches (166 mm.); spread of same at summits $8\frac{1}{4}$ inches (210 mm.); height of posterior horn cores above plane of molars $7\frac{3}{4}$ inches (197 mm.); spread of same at widest point 10 inches (254 mm.); width of palate between molars $1\frac{1}{4}$ inches (32 mm.).

No attempt should be made at this juncture to fully define the genus. As to its affinities, *Syndyoceras* seems to be remotely related on the one hand to *Protoceras* of the Oligocene, and on the other hand to the modern antelopes. *Syndyoceras* may be placed for the present with the Protoceratidæ, but it is doubtless entitled to a place in a new family.

ERWIN HINCKLEY BARBOUR.
THE UNIVERSITY OF NEBRASKA, LINCOLN,
October 1, 1905.

NOTE ON THE FUNCTIONS OF THE FINS OF FISHES.

THE exact determination of the function of each kind of fin in fishes does not appear to have been treated in a practical manner up to the present time, and these organs are in general regarded as of little importance for swimming. It occurred to me that a few experiments might elucidate the question. Unfortunately, I had and can have, at my disposal, only fishes with fins but little developed and in small number, so that the facts which I am going to set forth have only a relative bearing, and only naturalists having sufficient material at their disposal will be able to establish general rules.

I had in the aquarium of the state college three or four small specimens of *Goodea atripennis* (a cyprinodont) four or five centimeters long, taken in a pond in the state of Guanajuato. One of these individuals attracted my attention by the entire absence of its dorsal fin; whether it had disappeared by accident or whether it had never existed was not evident. Since the creature swam exactly like those which were perfect, I thought of investigating the function of this fin and also of the others, both paired and single.

No. 1. Individual without dorsal fin. My preparator cut off the anal fin close to the body. No difference whatever was observed in the creature's movements. I conclude that, in *Goodea* at least, this organ exerts no influence in swimming or on the equilibrium.

No. 2. I took another fish and had the pectorals and the ventrals amputated, that is to say, the four members. At first the creature appeared somewhat astonished and hesitating; but at the end of an hour it finished by moving deliberately and swimming as usual. The pairs of fins appear, therefore, to have very little if any bearing on locomotion.

No. 3. A third *Goodea* served for the study of the caudal fin. That alone was cut off.

The fish remained at the bottom of the aquarium and went slowly to take refuge under a tile which served as a shelter. It was then three o'clock in the afternoon. The next day at the same hour I found it in a package of *Jussieua* plants which was floating on the surface of the water.

In order to examine my fishes closely, I removed the plants and observed that Nos. 1 and 2 did not appear to be at all influenced by the operation which they had undergone. Only No. 2, deprived of its pectoral and ventral fins, seemed unable to move easily. No. 3 moved the posterior portion of its body quickly, and by uninterrupted lateral shakes was able to turn, rise, fall and swim forward, but with much less rapidity and ease than the others, which, with a stroke of the tail, darted like arrows without needing to strike the liquid again in order to advance. The third fish ended by learning to replace his caudal by the movements of the dorsal and anal, which increased a little in size, doubtless from the exercise.

One more experiment remained to determine the functions of the fins and of the air-bladder. All the fins except the caudal were cut off of one fish. The creature thus mutilated at first appeared undecided, like No. 3, and moved slowly at the bottom of the aquarium; but the next day I saw him swim rapidly and execute with agility all his usual evolutions. The only noticeable peculiarity was that in order to keep himself in position he caused his only fin to vibrate rapidly and constantly, and that these vibrations communicated a trembling to the entire body. The equilibrium was, therefore, still preserved, and the air-bladder did not cause the fish to turn belly upwards, although he maintained himself at the bottom of the water, in the middle or at the surface, experiencing in consequence a series of different pressures. My friend, the learned Belgian professor, F. Plateau, so well known by his experiments on insects, and who encouraged me to publish these studies, writes to me that he teaches his pupils that locomotion in most fishes is effected by flexions of the entire caudal portion of the body, and that the undulations of the odd fins (dorsal, anal and caudal) serve only to give more precision to the general movements of locomotion; and that, save in exceptional cases, the functions of the pairs of fins are almost inappreciable. I am happy to see my observations accord with the ideas of a savant whose name carries weight.

When my fishes swim slowly or remain motionless, the caudal fin executes very clean helicoid movements (skulling). This fin appears, therefore, to be, not indispensable, but extremely useful in swimming. Progression forward is due to the alternate flexions of the tail, that is to say, of the part of the body situated behind the anus, as everybody knows; but, according to the observation made on No. 3, it is evident that the fin which terminates it lends it a very powerful aid, for both rapidity and uniformity of motion. With regard to the function of the pectorals, I have remarked that when the fishes which possessed them remained stationary they, nevertheless, continued to move these fins rapidly, and that the latter appeared to be intended to produce currents in the water to renew the portions of this fluid which had already yielded their oxygen to the gills and remained charged with carbonic anhydride.

It is evident that these experiments on a single species and on so small a number of fishes are insufficient to determine in a general manner the rôle of each kind of fin, and I publish them only to instigate other more varied studies, particularly by means of fishes provided with well-developed fins. With regard to those vertebrates which possess only the caudal, it is known that the shape of their body, especially of the posterior portion, perfectly explains direct progression.

Before closing this article, I wish to call attention to a fact which perhaps has not yet been observed, or at least not published. The amputated dorsal fin and the two pectoral fins have grown out again to a great extent. It is probable that the mutilated fishes continued mechanically to make use of the stump which remained to them, doubtless with a small fragment of the fin, and that under that action the

rest of the organ reproduced itself. What would seem to prove it is the fact that, as I have said in speaking of No. 3, the dorsal fin increased in size on account of the use he made of it to replace the amputated caudal fin.

A. DUGÈS.

GUANAJUATO, MEXICO,
April, 1905.

LABORATORY EXPERIMENTS WITH CS_2 TO DETERMINE THE LEAST AMOUNT OF GAS AND THE LEAST TIME REQUIRED TO KILL CERTAIN INSECT REPRESENTATIVES OF VARIOUS FAMILIES.[1]

WHILE a sufficiently large series of insects has not yet been worked upon to draw a definite conclusion upon the above point, the following paper is submitted as showing some interesting results incident to this work. Experiments were begun in California a few years ago, and continued for a time in Minnesota. Three hundred and eighty-six insects have been tested. Of this number some have not been included in the tables, where the record was not regarded as sufficiently complete.

The points which might be brought out by an exhaustive series of observations in this line are as follows: Least strength required with a minimum expenditure of time to kill (*a*) insects in general, (*b*) particular groups, safety to foliage being understood; effect of moisture upon results; effect of temperature upon results; expense of material for effective use upon a known number of plants, trees, insect colonies or stored products, what per cent., if any, succumbed after seeming recovery; beginning effects of gas upon (*a*) insects in general, (*b*) groups in particular; significance of occasional spasmodic movements of legs, wings, sometimes long after apparent death; corroboration of laboratory results with results from the field as far as possible; different results with different brands of CS_2; corroboration with previous published statements.

Method and Apparatus Described; Computation.—The necessary crudity of the apparatus and method described is evident, and must render the results in the case of insects of any size not even approximate. An insect as large as *Ectobia,* or *Apis mellifica,* for example, or the larva of the western peach-tree borer, or that of the Mediterranean flour moth, evidently displaces so much of the gaseous contents of a vial when introduced, as to render absurd the proportions of gas to atmosphere as given. Even in insects smaller than these there is undoubtedly an error due to displacement, yet the writer believes that the method described here comes as near demonstrating facts in this connection as possible, particularly in the case of very small insects, and it has certainly brought out interesting results, from which we may select what appears authentic.

A large number of homeopathic vials were secured, of the same size (homeopathic 2 gram vial No. 1,657 with patent lip), also pieces of flexible rubber piping of such a size as to fit tightly over these vials. Into one vial a drop of CS_2 was allowed to fall from a medicine dropper, and the mouth of this vial immediately placed against the mouth of another empty vial, the rubber tubing referred to serving to hold the two vials closely together, and preventing any egress of gas, or entrance or exit of atmosphere.

The average capacity of these vials was 8.7 c.c., and it was upon this basis that our calculations were made. The volume of gas coming from one drop of CS_2 equaled 4.35 c.c., and, therefore, filled half a vial.

It is evident, therefore, that the union of the first two bottles, made immediately, before the gas had an opportunity of driving out any of the atmosphere, caused a mixture of one part of gas to four of atmosphere; the second change, one to eight; the third, one to sixteen; the fourth, one to thirty-two, etc., or, interpreting it with reference to the liquid volume of CS_2 to the atmosphere, we find that the union of the first two bottles equaled one part of liquid CS_2 to 1,494 parts of atmosphere, or in round numbers, 1,500 parts of atmosphere; the second change, one part of liquid CS_2 to 2,988 parts of atmosphere, or in round num-

[1] Abstract of paper read before the Association of Economic Entomologists at Philadelphia at their last annual meeting.

bers 3,000 parts of atmosphere; the third change, one part of liquid CS_2 to 6,000 parts of atmosphere; the fourth change, one part of liquid CS_2 to 12,000 parts of atmosphere, and so on.

The greatest pains were taken to secure volatilization of the liquid. Nearly half an hour was allowed to elapse after the drop was enclosed before changing bottles, and no change was made as long as the slightest evidence of the liquid CS_2 was observed.

confusum) were treated, of which fifty-eight were entered in tables as offering authentic results. Experiments with fifty-two diptera were tabulated, as were also experiments with fifty-six hemiptera (mostly aphids). Forty lepidopteran larvæ were used and results tabled, and thirty-one hymenoptera. A few entries in the tables are here given as an example of the method employed, and at the same time offering an illustration of the somewhat remarkable vitality of the Aphidæ.

No.	Name.	Strength.	Exposure. hr. m.	Died.	Recovered.
31	Aphid.	1–24,000	27		9 minutes—died later.
32	"	1–24,000	25		41 "
33	"	1–24,000	20	Yes.	
94	"	1–12,000	2 4	"	
123	Mealy Bug.	1–12,000	50		2 hours 20 minutes.
124	" "	1–12,000	54	"	
125	" "	1–24,000	1 8	"	
126	" "	1–24,000	1 12		Next A.M.
127	" "	1–24,000	28	"	
128	" "	1–48,000	1 20	"	
129	" "	1–48,000	2 38	"	
130	" "	1–48,000	1 7		
131	" "	1–24,000	15	"	
132	Aphid ad. wgl.	1–24,000	14		4 hours 25 minutes.
133	" juv.	1–24,000	14		4 " 25 "
134	" "	1–24,000	13		4 " 25 "
135	" "	1–24,000	13		4 " 25 "
136	" "	1–24,000	12		4 " 25 "
137	" "	1–24,000	12		4 " 25 "
138	" "	1–24,000	11		4 " 25 "
139	" "	1–24,000	11		4 " 25 "
140	" ad. wgl.	1–48,000	1 42		1 hour 18 "
141	" "	1–48,000	44		1 " 7 "
142	" juv.	1–48,000	1 42	"	
143	" "	1–48,000	1 38	"	
144	" "	1–48,000	1 41		1 " 7 "
145	" "	1–48,000	1 40		2 hours
146	" "	1–24,000	1 8	"	
147	" "	1–24,000	1 8		Next A.M.
148	" "	1–24.000	2 21	"	
149	" "	1–24,000	2 30	"	
150	" "	1–24,000	2 22	"	
151	" "	1–48,000	2 12	"	
152	" "	1–48,000	2 08	"	

Now then, it is evident that if our calculations are correct, we could by placing it in an empty vial, and then applying it as above described to one of the vials containing a mixture of gas and atmosphere, expose an insect to any desired proportion of gas and atmosphere.

One hundred and fifty-six specimens of coleoptera (largely composed of *Tribolium*

Conclusions.—The experiments demonstrate that it is very much easier to kill diptera than coleoptera. It is further to be noted that insects are apparently dead long before death actually occurs. I have no doubt but that there is an immediate effect upon the individual insect coming in contact with the gas, although it does not always show this. By 'effect' as noted in the tables, we mean the

first marked uneasiness on the part of the insect under treatment. In some cases this effect is immediate.

It is to be also noted in this particular that in the case of many specimens the first noticeable effect was an attempt on the part of the insect to clean its antennæ. The striking individual variations, in other words, the revival of many subjects after apparent death, show the necessity of extreme thoroughness in field and greenhouse, that is, a long enough exposure to insure carrying the insect beyond all possibility of recovery.

One hour's exposure to one part liquid CS_2 to 12,000 parts of atmosphere is apparently sufficient to kill aphids, but in making suggestions for practical application, I should certainly urge an hour and a half's exposure to that strength as being more sure, especially with crude CS_2. Ants appear generally to succumb to one hour's exposure to one part liquid CS_2 to 12,000 parts of atmosphere, the same as aphids, and yet in actual practise, to insure the best results, they should be subjected to a longer treatment. Aphids show immediately the effect of exposure, and some were on their backs from two to four minutes after treatment, and yet recovered after an exposure of three fourths of an hour to one part liquid CS_2 to 12,000 parts of atmosphere. *Tribolium confusum* was observed particularly to clean the antennæ immediately upon exposure.

The remarkable vitality of the Aphidæ (insects that we commonly regard as extremely delicate) is to be noted in connection with this work. Further, in a few cases we found that some of the insects which recovered such treatment died later, say within twenty-four hours, although the bottles in which they were confined were left open, only slightly plugged with absorbent cotton. This 'apparent death' is very deceiving. To all appearances these insects were absolutely dead, perfectly motionless, and in many cases we entered them on the record as dead, although we had to change that record several minutes later, when a wing, a leg or an antenna would be seen to move. Frequently only a slight movement of the mouth parts, all other appendages being quiescent, would indicate that the insect treated was still alive.

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A NOTE ON THE CALCULATION OF CERTAIN PROBABLE ERRORS.

The purpose of this note is to call the attention of workers in biometry to a point which serves to lessen somewhat the labor of computation in the frequently arising cases when one wishes to test whether a given frequency distribution obeys the normal law. Though sufficiently obvious, the point seems not to have been noticed.

In determining whether a given distribution of frequency follows the normal or Gaussian law it has been shown by Pearson[1] that the important constants are

$$\sqrt{\beta_1}=\sqrt{\frac{\mu_3^2}{\mu_2^3}},$$

$$3-\beta_2=3-\frac{\mu_4}{\mu_2^2},$$

$$\text{the skewness}=\tfrac{1}{2}\,\frac{\sqrt{\beta_1}(\beta_2+3)}{5\beta_2-6\beta_1-9},$$

and the 'modal divergence,'

$$d=\text{skewness}\times\sigma.$$

All these constants should equal zero within the limits of the error due to random sampling if the distribution be truly normal.

The probable errors concerned are (for the normal distribution), when $N=$ the total number of individuals,

$$\text{Probable error of skewness}=.67449\sqrt{\frac{3}{2N}},\qquad\text{(i)}$$

$$\text{Probable error of}\quad\sqrt{\beta_1}=.67449\sqrt{\frac{6}{N}},\qquad\text{(ii)}$$

$$\text{Probable error of}\quad\beta_2=.67449\sqrt{\frac{24}{N}},\qquad\text{(iii)}$$

$$\text{Probable error of}\quad d=.67449\sqrt{\frac{3}{2N}}\cdot\sigma.\qquad\text{(iv)}$$

It is at once clear that the values of expressions (i), (ii) and (iii) stand in the relation to each other of

$$1:2:4.$$

[1] *Biometrika*, Vol. 4, pp. 169–212.

So then in practise it will be necessary to calculate from the formula only one of these probable errors for a given distribution, viz., the probable error of the skewness. Having determined this we need only to multiply it by 2, by 4 and by σ to obtain the values for the other three. RAYMOND PEARL.

BOTANICAL NOTES.

HALLIER'S NATURAL SYSTEM.

IN the July number of *The New Phytologist* Professor Dr. Hans Hallier discusses further his provisional scheme of the phylogenetic system of flowering plants. The general features of his system are: (1) the Angiospermae constitute a monophyletic group; (2) the Amentaceae are not an old type remaining in a lower state of development, but as 'the highest and most reduced types of one of the lines of Dicotyledons'; (3) they and all other lines of Dicotyledons have been developed by reduction of flower and fruit from the *Polycarpicae*, the latter group being derived immediately from *Bennettitaceae* or other extinct Cycadales; (4) in the same manner, the *Liliiflorae* and all other syncarpous Monocotyledons have been derived by union of the carpels, by reduction in the number of parts, by epigynous insertion of the perianth, and by other changes in the structure of flower and fruit from the polycarpous Monocotyledons (*Helobiae*), which latter group originated from the polycarpous Dicotyledons (*Polycarpicae* and *Ranales*); (5) the *Apetalae* and *Sympetalae* are unnatural groups.

In applying these general principles, Dr. Hallier has worked out the following arrangement of the Dicotyledons, which he distinctly says is provisional for all after the Piperales.

1. POLYCARPICAE (*Magnoliaceae, Canellaceae, Anonaceae, Myristaceae, Calycanthaceae, Monimiaceae, Lauraceae*).

2. RANALES (*Berberidaceae, Menispermaceae, Ranunculaceae, Nymphaeaceae, Ceratophyllaceae*).

3. RHOEDALES (*Papaveraceae, Capparidaceae, Resedaceae, Cruciferae*).

4. PIPERALES (*Lactoridaceae, Piperaceae, Chloranthaceae, Myrothamnaceae*).

5. MALVALES (*Sterculiaceae, Papayaceae, Euphorbiaceae, Bombacaceae, Malvaceae, Elaeocarpaceae, Tiliaceae, Rhamnaceae, Urticaceae, Dipterocarpaceae*).

6. EBENALES (*Sapotaceae, Convolvulaceae, Ebenaceae, Symplocaceae, Styracaceae*).

7. GERANIALES (*Zygophyllaceae, Cneoraceae, Oxalidaceae, Geraniaceae, Linaceae*).

8. MYRTIFLORAE (*Lecythidaceae, Caryocaraceae, Rhizophoraceae, Lythraceae, Myrtaceae, Melastomaceae, Combretaceae, Geissolomaceae, Penaeaceae, Oliniaceae, Thymelaeaceae, Elaeagnaceae*).

9. ROSALES (*Saxifragaceae, Rosaceae, Anacardiaceae, * * * * Meliaceae, Rutaceae, * Leguminosae, * * * * * * * Sapindaceae, * Celastraceae, * Aquifoliaceae, * * * * * Guttiferae, * * Dilleniaceae*).

10. ERICALES (*Clethraceae, Pirolaceae, * Ericaceae, * * * Diapensiaceae, * * Primulaceae*).

11. SARRACENIALES (*Sarraceniaceae, Droseraceae*).

12. SANTALALES (*Olacaceae, Ampelidaceae, * Santalaceae, Myzodendraceae, Gnetaceae, Loranthaceae*).

13. UMBELLIFLORAE (*Cornaceae, Araliaceae, Adoxaceae*).

14. AMENTIFLORAE (*Hamamelidaceae, Myricaceae, Salicaceae, Juglandaceae, Betulaceae* (incl. *Casuarineae*), *Fagaceae*).

15. PASSIFLORALES (*Flacourtiaceae, Violaceae, Cistaceae, * * Passifloraceae, * * * Onagraceae, * * * Gentianaceae, Aristolochiaceae, Rafflesiaceae, Loasaceae, Begoniaceae, Cucurbitaceae, Campanulaceae, * * * Compositae*).

16. CENTROSPERMAE (*Crassulaceae, Cactaceae, * * * * Portulacaceae, * Phytolacaceae, Tamaricaceae, Caryophyllaceae, Polygonaceae, * * Amarantaceae, Chenopodiaceae, Batidaceae*).

17. CAPRIFOLIALES (*Caprifoliaceae, Valerianaceae, Dipsaceae*).

18. TUBIFLORAE (*Apocynaceae, Loganiaceae, Rubiaceae, Bignoniaceae, Oleaceae, * * Acanthaceae, Verbenaceae, Labiatae, Scrophulariaceae, * Solanaceae, Polemoniaceae, Boraginaceae, Hydrophyllaceae*).

The arrangement of the Monocotyledons is merely begun, the families of the Helobiae alone being given (*Butomaceae, Alismaceae, Hydrocharitaceae, Potamogetonaceae, Aponogetonaceae, Juncaginaceae, Triurdiaceae*).

We can agree with the author in regard to the general plan of his system, of which he says: "I freely confess that it gives only an approximate idea of lines of descent and of the natural relations of the flowering plants: it is only one step in the further progress of phylogenetic botany. But I am sure that this step is not a wrong and useless one, and that it will lead to a broader knowledge of the flowering plants."

THE AMERICAN FOREST CONGRESS.

EARLY in the present year (January 2 to 6) the American Forest Congress was in session in Washington, D. C. Its purpose was 'to establish a broader understanding of the forest in its relation to the great industries depending upon it: to advance the conservative use of forest resources for both the present and future need of these industries: to stimulate and unite all efforts to perpetuate the forest as a permanent resource of the nation.' The papers read in this congress have been collected by Mr. H. M. Suter and published in a volume of 475 pages. These have been arranged systematically under the following heads. (1) 'Forestry as a National Question'; (2) 'Importance of the Public Forest Lands to Irrigation'; (3) 'The Lumber Industry and the Forests'; (4) 'Importance of the Public Forest Lands to Grazing'; (5) 'Railroads in Relation to the Forest'; (6) 'Importance of Public Forest Lands to Mining'; (7) 'National and State Forest Policy.' The book possesses much value, not only to foresters, but to botanists as well.

MORE PLANT CELL STUDIES.

THE series of articles by Bradley M. Davis entitled 'Studies on the Plant Cell,' which began in the May number (1904) of the *American Naturalist*, has been brought to a close in the October number (1905), and we have now the whole work before us. In looking over its pages, we are more and more impressed with its value and importance to students of plant cytology, since it presents a summary of the results of recent work not attainable elsewhere. It is to be hoped that the author may be able to push to early completion the preparation of a book on cytology planned to follow pretty closely the outlines given in these studies. In the meantime, many botanists will be glad to know that reprints of these papers are obtainable of the author, at the University of Chicago.

The closing section, which covers about forty-five pages, is devoted to the 'Comparative Morphology and Physiology of the Plant Cell.' About a dozen pages are given to the simplest types of cells, as they occur in the blue green algae, the bacteria and the yeasts, and a clear summary is made of the views of the investigators of these low plants. The author is able, from the incomplete and somewhat conflicting testimony, to find some justification of the belief in the presence of nuclear structures, even in the smallest bacteria. Interesting comparisons are made of the structure of simpler plant cells with those of higher types, in which many gaps in our knowledge are pointed out, one of which is the connection of the Schizophyta with the lower green algae. The structure of the trophoplasm, the reproduction of plastids, the individuality of the chromosomes, the functions of the vacuoles, the nature and occurrence of centrosomes, the balance of nuclear and cytoplasmic activities, are among the topics discussed in the closing pages of this interesting section, which, like the preceding sections, is followed by an extensive bibliography.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

THE AMERICAN CHEMICAL SOCIETY.

THE sessions of the thirty-third general meeting of the American Chemical Society and those of Section C of the American Association for the Advancement of Science will be held in the lecture rooms of Tulane University, New Orleans, from December 29 to January 2.

The preliminary program is as follows:

FRIDAY, DECEMBER 29.

Forenoon.—At the close of the general session of the American Association for the Advancement of Science, Section C will hold a brief session for organization. This will be followed by the opening session of the American Chemical Society in the same room at about 11:45 A.M. Two addresses will be given: 'Some Important Problems in Agricultural Chemistry,' by Harvey W. Wiley; 'Recent Experimental Researches on Osmosis,' by Louis Kahlenberg.

Afternoon, 2:30 P.M.—Address of the retiring chairman of Section C of the American Association for the Advancement of Science, Leonard P. Kinnicutt. Subject: 'The Sanitary Value of a Water Analysis.'

SATURDAY, DECEMBER 30.

Forenoon.—Session of the American Chemical Society at 9:30 A.M. Subject: 'The Construction of a Chemical Laboratory,' by William L. Dudley. This will be followed by meetings of the sections: Physical and Electrochemical, Louis Kahlenberg, chairman; Inorganic, William L. Dudley, chairman; Organic, Charles F. Mabery, chairman; Agricultural and Sanitary, Harvey W. Wiley, chairman; Industrial, Samuel W. Parr, chairman.

If enough papers are offered to warrant it, a biological section will be formed, with William J. Gies as chairman.

Afternoon, 2 P.M.—Excursions to visit industrial establishments. The following excursions have been suggested, but the exact details are not yet arranged: Visits to a sugar refinery, a molasses distillery, a cotton-seed oil mill, cotton compress, plants for the distillation of wood and for the manufacture of vinegar by the rapid process from molasses, fertilizer works and rice mills.

Evening, 8 P. M.—The retiring president of the American Chemical Society, Francis P. Venable, will deliver an address upon the subject of 'Chemical Research in the United States.'

MONDAY, JANUARY 1.

Forenoon, 9:30 A. M.—General meeting of Section C of the American Association for the Advancement of Science, at which Professor Charles F. Mabery will preside. Addresses: 'The Composition of Petroleum from American Fields—Pennsylvania, Ohio, Texas, Kansas, Wyoming, Colorado, Kentucky and California,' by Charles F. Mabery; 'Some Notes on the Service Waters of a Railway System,' by Samuel W. Parr. These addresses will be followed by meetings of the sections.

Afternoon, 2 P.M.—Excursions to visit industrial establishments.

Evening, 7 P.M.—A subscription dinner open to all chemists in attendance on the meeting.

TUESDAY, JANUARY 2.

Forenoon, 9:30 A.M.—Meetings of the sections, or visits to industrial establishments, according to the exigencies of the program.

RAILWAY RATES FOR THE NEW ORLEANS MEETING.

The railway rates for the New Orleans meeting of the American Association for the Advancement of Science are now all in. As already noted in previous numbers of Science and in the preliminary announcement, which is now in the hands of all members, a standard rate of one fare plus twenty-five cents for the round trip has been granted by the Southeastern Passenger Association and by the Central Passenger Association. The Southeastern Passenger Association includes the territory south of the Ohio and Potomac Rivers and east of the Mississippi except that in West Virginia the territory is south of Charleston and in Virginia the town of Staunton is in the Trunk Line Association. The Central Passenger Association includes the whole of Michigan, Ohio and Indiana, the northwest corner of Pennsylvania and lower Ontario, in addition to the southern and eastern portion of Illinois. The Trunk Line Association, including New York, New Jersey, Delaware and Maryland, and all of Pennsylvania, except the northwestern corner, West Virginia north of Charleston, and northwestern Virginia, offers one fare and one third to the southern or western termini of Trunk Line railroads, and one fare plus twenty-five cents from those points. The Western Passenger Association, including the northern peninsula of Michigan, Wisconsin, Minnesota, the eastern half of North Dakota, all of South Dakota, Nebraska, Iowa, Kansas, the northern portion of Illinois, the northern portion of Missouri north of St. Louis, and the eastern half of Colorado, offer one fare plus two dollars for the round trip, except that from points from which the local railway rate to the eastern gateways of the Association (Chicago, Peoria and St. Louis)

is six dollars or less through rate is made on the basis of fare and one third for the round trip to such gateways added to rate of one fare plus twenty-five cents for the round trip tendered therefrom, provided that where such one and one-third fare to Chicago is two dollars or less, fifty cents additional be added for return transfer. The Southwestern Excursion Bureau, which includes all of Texas, Missouri south of St. Louis, and a central strip through Illinois up to Chicago, offers one fare plus two dollars. The Trans-Continental Passenger Association, which includes the Pacific coast states, offers rate of approximately two cents per mile, or about one fare and a third for the round trip.

The purchasing dates are as follows: Trunk Line Association from Washington, December 26, 27, 28, 29; from other points, December 26, 27, 28. Central Passenger Association, December 26, 27, 28. Southeastern Passenger Association, December 27, 28, 29. Western Association, December 26, 27, 28.

The date of return is arranged so that ticket holders must reach original starting point not later than January 6 in all cases, except under the Trans-Continental Association.

SCIENTIFIC NOTES AND NEWS.

A CABLEGRAM to the daily papers states that the Nobel prize in medicine has been awarded to Professor Robert Koch, of Berlin, the prize in physics to Professor Philipp Lenard, of Kiel, and the prize in chemistry to Professor Adolf von Baeyer, of Munich.

DR. ALBRECHT PENCK, professor of geography in the University of Vienna, has been elected a member of the Vienna Academy of Sciences. Dr. Richard Hertwig, professor of zoology at Munich, has been elected a corresponding member of the same academy.

THE Geological Society of London has elected Professor Louis Dollo, Brussels, and Professor A. Rothpletz, Munich, to be foreign members in the places of Baron F. von Richthofen and Professor Gustave Dewalque, both recently deceased.

DR. WILHELM WUNDT, the eminent psychologist of the University of Leipzig, celebrated the fiftieth anniversary of his doctorate on November 10.

DR. E. EHLERS, professor of zoology at Göttingen, who celebrated his seventieth birthday on November 11, has been elected a corresponding member of the Senckenbergische Naturforschende Gesellschaft at Frankfurt.

THE council of the Royal Meteorological Society has awarded the Symons gold medal to Lieutenant-General Sir Richard Strachey, G.C.S.I., F.R.S.

PROFESSOR C. S. SHERRINGTON, F.R.S., and Professor R. Threlfall, F.R.S., have been elected honorary fellows at Gonville and Caius College, Cambridge.

PROFESSOR C. S. SARGENT, of Harvard University, has sailed for Chili and the mountains of South America to obtain specimens for the Arnold Arboretum.

PROFESSOR WILHELM OSTWALD addressed the Washington Academy of Sciences on November 28, on 'The International Language.' The address was discussed by Professor Maurice Bloomfield, of the Johns Hopkins University, and by Professor M. Carroll, of the George Washington University.

PROFESSOR A. V. STUBENROUCH, of the University of California agricultural department, has accepted a position in the division of pomology in the Bureau of Plant Industry of the United States Department of Agriculture.

CAPTAIN ADMUNDSEN, as the daily papers have fully reported, has succeeded in passing through the Northwest Passage, and making observations about the North Magnetic Pole.

SIR CLEMENTS MARKHAM lectured before the Royal Geographical Society on November 13, on 'The Next Great Arctic Discovery,' which he held to be exploration over the continental shelf of Beaufort Sea.

PROFESSOR HERBERT C. SADLER, of the department of marine engineering at the University of Michigan, has returned from a trip in the east, where he attended a meeting of the Society of Naval Architects and Marine Engineers in New York City. During his absence he delivered a lecture before the marine engineering department of the Boston Polytechnic Institute on 'The Present Status

of the Turbine in Marine Work.' Since Dr. Sadler's return the big naval tank in the new engineering building has been filled with water and the long and tedious task of testing has begun. The tank is now being tested for leakage and evaporation and it is thought that the different tests necessary before the tank can be used will occupy nearly the whole year.

THE funeral services of Sir John Scott Burdon-Sanderson, formerly regius professor of medicine, in the University of Oxford, took place at Magdalen College, Oxford, on November 8. Many members of the university and men of science were present.

DR. W. J. MCMURRAY, president of the Tennessee State Board of Health, died at Nashville, on December 4, aged sixty-three years.

MR. J. S. BURCHAM, A.M. (Stanford, 03), was drowned in Alaska on November 12. He was in the employ of the United States Bureau of Fisheries, and was with the U. S. S. *Albatross* as an expert on salmon and other fishes.

THERE will be a civil service examination, on January 3, to fill the position of physical chemist in the Bureau of Weights and Measures, Manila, at a salary of $2,250. The examination consists only of ratings on training, experience and publications. On the same day there will be an examination to fill the position of teacher of agriculture in the Chilocco School, Okla., at a salary of $1,000.

THE trustees of the British Museum have presented the trustees of the Carnegie Museum with a fine series of reproductions of some of the more striking and important paleontological specimens in their collection, and have also made a gift of all their publications to the museum. This act of courtesy is in recognition of the kindness displayed by Mr. Carnegie in placing in the British Museum a facsimile of the skeleton of the great reptile Diplodocus, which was installed at South Kensington last May.

THE fifth meeting of the California Branch of the American Folk-Lore Society was held in Berkeley, on December 7. Professor William Frederic Badè, of the Pacific Theological Seminary, gave a lecture on 'Hebrew Folk-Lore.'

AN organization to be known as the Conference of New England Professors of Education was formed at a meeting held at Harvard University, on December 1. Discussion on 'The aims, scope, means and methods of the work of the department of education in colleges and universities' was led by Professor W. B. Jacobs, of Brown University, and President Hall, of Clark University. Professor P. H. Hanus, of Harvard, was elected president, and W. B. Jacobs, secretary. The next meeting will be held on the Friday following Thanksgiving next year.

THE yacht *Galilee*, engaged in the magnetic survey of the North Pacific Ocean under the auspices of the Department Terrestrial Magnetism of the Carnegie Institution of Washington, arrived at San Diego, on December 9, having completed a successful series of magnetic observations embracing the regions between San Francisco, San Diego, Honolulu, Fanning Island and the magnetic equator.

FOR the best essay on 'Moral Training in Public Schools' a prize of five hundred dollars is offered, and for the second best, three hundred dollars. The conditions are: (1) Length of essay to be not less than 6,000 nor more than 12,000 words; (2) each essay must be submitted typewritten; (3) all essays must be in the hands of the committee not later than June 1, 1906. These prizes are offered by a citizen of California who desires his name withheld. He has appointed Rev. Chas. R. Brown, of Oakland, California; President David Starr Jordan, of Stanford University, and Professor F. B. Dresslar, of the University of California, Berkeley, 'trustees of the fund and sole judges of the merits of the essays submitted.' The two prize essays shall become the property of the trustees, to be by them 'published and circulated as widely as possible' from the fund at their disposal 'within the limits of the United States.' Any essay not awarded a prize will be returned to the writer upon request, accompanied by postage.

THE Mercers' Company has made a grant of £250 to the Middlesex Hospital Cancer Charity; £150 is to be allotted to the Cancer Research Fund, of which £50 is to be awarded

to one of the workers of the cancer research laboratories, and styled 'The Mercers' Prize.'

The Royal Scottish Geographical Society celebrated its twenty-first anniversary at Edinburgh on November 27, with the president, Professor James Geikie, in the chair.

The Wisconsin Archeological Society has now a total membership of 500. They are securing the custodianship, for school purposes, of the last group of mounds remaining in Milwaukee. In the spring there will be held a joint meeting of the Wisconsin Landmarks Committees and of the Wisconsin Archeological Society, under the auspices of the latter. This meeting will be held among the mounds preserved on the campus of Carroll College, Waukosha. They will soon have completed the details of the preservation of the celebrated 'man' mound at Baraboo.

A national society for the preservation of the American bison was organized on December 8 at the office of Mr. William T. Hornaday, director of the New York Zoological Park. President Roosevelt has consented to hold office in the society.

UNIVERSITY AND EDUCATIONAL NEWS.

Through the will of the late Dr. A. F. Elliott, of California, the University of California will receive $200,000 for the erection of a public hospital.

Dr. Albert Goldspohn has given $25,000 for the erection of a science hall at the Northwestern College, Naperville, Ill.

The faculty of the University of Wisconsin at its last meeting discussed the present status of intercollegiate athletics, and decided to appoint a committee of seven of its members to consider the problem of intercollegiate sports as now conducted and to report to the university faculty the results of its deliberations. President Van Hise has appointed the following members to this committee: Dean E. A. Birge, of the College of Letters and Science, Dean F. E. Turneaure, of the College of Engineering, Professors D. C. Jackson, D. C. Munroe, C. S. Slichter, A. Trowbridge and F. J. Turner.

Plans being completed by Professor D. C. Munroe, director of the University of Wisconsin summer session, provide for the appointment of a number of non-resident professors to take the place of those members of the faculty who do not desire to give instruction in the summer session. The appointments already made include Professor Albert Perry Brigham, head of the department of geology of Colgate University, who will give courses in the principles of physiography and the physiography of the United States. He will also conduct excursions to points of geologic and physiographic interest about Madison, including Devil's Lake, the Dells of the Wisconsin River, Blue Mounds, which have been such an important feature of the summer work in geology.

Professor P. H. Rolfs, at present in charge of the subtropical laboratory of the U. S. Department of Agriculture, at Miami, Florida, has been elected director and horticulturist of the Florida Experiment Station. He was connected with that institution for several years previous to entering the service of the Deparment of Agriculture.

Theodore de Leo de Laguna, A.B. (California), Ph.D. (Cornell), has been made assistant professor of education in the University of Michigan, to fill the place left vacant by the resignation of Professor Alger.

Dr. H. R. Moody, of Hobart College, has been appointed assistant professor of chemistry at the College of the City of New York.

The following changes have taken place in the faculty of the Colorado School of Mines this year: W. G. Haldane has been advanced from instructor to assistant professor of metallurgy; W. F. Allison from instructor in surveying to assistant professor of civil engineering; C. E. Smith has been appointed instructor in geology to take the place of J. W. Eggleston, who resigned to accept an instructorship in Harvard University, and A. J. Hoskins, formerly with the Leyden Coal Company, was appointed assistant professor of mining engineering. Under the new administration the laboratory equipment, especially in ore dressing, is rapidly increasing.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, DECEMBER 22, 1905.

CONTENTS.

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE NEW ORLEANS MEETING.

THE meeting of the American Association for the Advancement of Science at New Orleans is a further step towards making the association truly national and representative of the men of science of the whole country. There has been a natural tendency for the association and its affiliated societies to meet near the center of scientific population, and it is of course under these conditions that the largest number of members can be brought together. But our scientific workers are by no means confined to the eastern and central states. When the association in 1901 met for the first time west of the banks of the Mississippi it was a natural acknowledgment of the westward extension of scientific institutions. The meeting at Denver was decided on with some hesitation, but it proved to be one of the most interesting in the history of the association. Not since 1850 has the association met further south than Nashville and St. Louis. But the south is now making marvelous progress in its material resources, and its educational and scientific development will soon be in equal measure. Tulane, Texas and other universities already occupy a foremost position, and their growth as centers of scientific research is certain.

A meeting of the association at New Orleans is a proper acknowledgment of

what has been accomplished in the south and an encouragement for further efforts. It will be attended by a large number of scientific men who live within a radius of 500 miles, and should prove unusually attractive to those living in the eastern, north central and western states. The southern and central passenger associations have granted a return ticket for one fare plus twenty-five cents, and this alone should lead many to enjoy a most pleasant and healthful trip. The association has not hitherto been able to obtain these terms, but the great meetings of the National Educational Association, reaching the tens of thousands, have been in large measure due to such arrangements, leading many to take an agreeable and profitable holiday trip at reasonable expense. Anybody who is tired or has a cold can not do better for himself than to go to New Orleans next week. But there are larger motives for those who are interested in the scientific development of the country and in the solidarity of scientific men to add to the success of the approaching meeting by their attendance. The best train for eastern members appears to be one over the Southern Railway, leaving New York at 4:25, Philadelphia at 6:50 and Washington at 10:45 P.M. After a day's journey over an interesting country, the train reaches New Orleans at 7:15 on the following morning. Those who take this train on Tuesday or Wednesday are sure to find good company, and the railway will supply a special car, should there be enough applications for berths.

The scientific program of the New Orleans meeting is of very considerable interest. The address of the retiring president, Professor W. G. Farlow, is entitled 'The Popular Conception of a Scientific Man at the Present Day.' The retiring vice-presidents will make addresses as follows:

Vice-President Ziwet, before the Section of Mathematics and Astronomy: 'On the relation of mechanics to physics.'

Vice-President Kinnicutt, before the Section of Chemistry: 'The sanitary value of a water analysis.'

Vice-President Smith, before the Section of Geology and Geography: 'On some Post-Eocene and other formations of the Gulf Region of the United States.'

Vice-President Merriam, before the Section of Zoology: Title to be announced later.

Vice-President Magie, before the Section of Physics: 'The partition of energy.'

Vice-President Robinson before the Section of Botany: Title to be announced later.

Vice-President Knapp, before the Section of Social and Economic Science: 'Transportation and Combination.'

Vice-President Jacobus, before the Section of Mechanical Science and Engineering: 'Commercial investigations and tests in connection with college work.'

Vice-President Hough, before the Section of Anthropology: 'Pueblo environment.'

The sectional programs will include many interesting papers. Thus the Section of Physiology and Experimental Medicine has arranged a timely discussion on 'Yellow Fever and other Insect-borne Diseases,' which will be taken part in by a number of leading students of the subject.

When the association meets in one of the large eastern cities, the interest is largely confined to the scientific programs. But New Orleans and the neighboring regions

have many of the attractions of a foreign country, which are entirely unknown to most scientific men of the eastern, central and western states. Further, it is a real privilege for the scientific men and other residents of the city to entertain the association for the first time, and the entertainments and excursions will be more attractive and characteristic than at the ordinary meetings.

The American Chemical Society, The Botanical Society of America and some seven other societies will meet with the association at New Orleans. But many of the national scientific societies will this year meet in widely separated places, as shown in the program printed under 'Societies and Academies.' It is natural that these societies, whose programs depend largely on a compact group of members, could not undertake the wider mission of the American Association. It is also true that there are attractions in smaller meetings in university towns, which can not be sacrificed without regret. It is to be hoped that ultimately convocation week will be left free for a national meeting of scientific men, and that the association will in the summer organize a less formal meeting at one of the smaller university towns or other places where social life may be informal and pleasant. Such a plan is proposed next year for Ithaca. The national societies devoted to special sciences will of course meet when and where their interests will be best served, but it is not likely that it will prove advantageous to meet at the same time as the larger group and in a different place. We may in any case count on an increasing spirit of cooperation among our scientific men and a gradual elimination of difficulties that are inevitable when adjustments must be made to new conditions. Perhaps all that can be expected or is desirable at present is that all scientific men should meet at the same place every second or third year. It was intended to arrange for a common meeting in Boston next year, but owing to the fact that the American Medical Association and the International Zoological Congress will meet in that city, it may be found wise to postpone the Boston meeting. In that case New York City appears to be the most desirable place for a convocation week meeting of the scientific men of the country.

ANTHROPOLOGY AT THE LOUISIANA PURCHASE EXPOSITION.[1]

I.

THE motive of the department was to diffuse and incidentally to increase knowledge of man and his works. Hence, the primary purpose was essentially educational; and the work of the department was distinctive, if not unique, in that it embraced research in a degree comparable with that accorded to original work in modern institutions of higher learning.

Anthropology is the science of man. In the broad sense it deals with all mankind and their attributes. Its aims and purposes are connected with man as an organism, and as the type of the class of living things distinguished by mentality; also it deals with mankind as an assemblage of

[1] Opening chapter of the final report of the chief of the department of anthropology, entitled 'Motive and Scope of the Department'; published with approval of Hon. David R. Francis, president, and Hon. F. J. V. Skiff, director of exhibits of the Louisiana Purchase Exposition.

varieties or races, and as social creatures united by language and law and organized in families, communities, societies, commonwealths and nations. In like manner the science in its broader aspects deals with man as a producer or creator of artificial things, and so as a progressive power in the conquest of lower nature; and in its highest aspect the science deals with the development of both man and his works, and seeks to trace the paths of human progress not only in the interest of definite knowledge concerning our own kind, but in the hope of wiser guidance toward future progress.

Such, in brief, is the broad science of anthropology; and of such were the field and the motives of the department.

II.

Practically, the field of anthropology is divided among several subsciences, each pertaining to a class of human attributes:

1. The science or subscience of man considered as an organism, or as the highest genus and species of the animal realm, is called physical anthropology or andrology; its object-matter is the individual human organism, or anthropos; its methods include anthropometry and the comparison of the characteristics obtained thereby. It embraces anatomy and physiology, and is closely related to the beneficent sciences connected with medical theory and practise.

2. Of late, the science of the human mind and of man as an organism dominated by mental power is called psychology; its object-matter is the psyche, individual and collective; it deals with the brain and nervous system considered in relation to bodily movements and actions, both individual and collective; its methods embrace psychometry and the comparison of the characters of individuals and classes ascertained thereby. Especially in the practical applications which grew up before the science assumed systematic form, it embraces several branches of more or less definite knowledge, and is related to the most important directive and repressive instrumentalities of modern life, including education, alienism and social regulation.

3. The still broader science of the human activities, or of man as a producer or creator, and also of human productions, is commonly known in its descriptive aspect as demography and in its systematic aspect as demology; its object-matter is the demos, or artificial group; it deals with what men do; and it embraces several subsciences each dealing with an important class of activities, viz., arts, industries, languages, laws and philosophies.

4. The science of man considered as an assemblage of races is known as ethnology; its object-matter is the ethnos, or natural group, of mankind defined in terms of physical, of mental, or of activital features or of these combined; and its methods combine those of the fundamental sciences (andrology, psychology and demology). In its descriptive aspect this is known as ethnography.

5. The several sciences dealing with man and his works touch that development or phylogeny of mankind in which lie the chief interest and value of anthropology; for whatever the immediate aims, it is the ultimate aim of the science to trace the course of human progress and classify individuals and peoples in terms of that progress, and thus to learn so much as may be of the origin and destiny of man. Up to the present, the field of systematic knowledge dealing with the progress of mankind (the science of human phylogeny, sometimes called anthropogeny) has not been clearly defined; for ever since Darwin and Huxley and Haeckel discussed the evolution of man, a third of a century ago, this has been the frontier of anthropology, the

campus of the leading pioneers, the virgin soil of teeming yield whence the richest fruits of each passing decade are gathered. Naturally, in view of the vigorous vitality symbolized by the Universal Exposition of 1904, the virile subject of human progress formed the leading motive of the department of anthropology—the exposition, indeed, affording the world's finest opportunity for framing the science and setting is on a firm basis. The objects-matter embrace the generations, families, stocks and races of men, with the human activities and products in their endless variety; the methods comprise observations and comparisons of growth, heredity, viability, fecundity, and development by exercise and cultivation, together with manufacture and other forms of production. Its leading divisions are: (1) archeology, or the science of human relics, with the human paleontology covering fossil and other remains of prehistoric man, and the paleography dealing especially with ancient writings; (2) history; and (3) the unclassified and nameless body of knowledge concerning current conditions and events in the human world.

Such, in general terms, are the main divisions of anthropology, outlined with special reference to the work of the department.

III.

It is a leading aim of anthropology to classify the peoples of the world in convenient and useful ways; and different classific systems have been devised.

The prevailing classification of mankind during the eighteenth and nineteenth centuries was ethnic, *i. e.*, the peoples of the world were divided into natural groups, defined chiefly by physical characteristics, called races. Partly by reason of limited information concerning the remoter peoples, ethnologists differed somewhat as to the definition and number of the races of mankind; some held that the world's peoples were better divided into twenty or thirty or even into fifty or more races, while others found it more convenient to reduce the number. During the later half of the nineteenth century there was a strong tendency to reduce the races or principal varieties of mankind to five, viz.: (1) the Caucasian or white race, especially characteristic of the central and western portions of the Eurasian continent; (2) the Mongolian or yellow race, inhabiting the eastern-central portion of the same continent; (3) the Malayan or brown race, occupying the southeastern border and islands; (4) the African or black race, inhabiting the continent of Africa; and (5) the Amerind or red race, inhabiting the two continents of America. This classification is simple and convenient, but open to the objection that certain peoples hardly fit any one of the five classes; the Japanese are neither white nor yellow nor brown, much less red or black, forming, indeed, an ethnologic puzzle, if not a distinct race; while the Blackfellows of Australia and the Papuans of New Guinea, the tribes of eastern Madagascar, various islanders of Polynesia, the Ainu of northern Japan, certain peoples of southern Eurasia with the Laps and Tartars of the north, the Eskimo of the western hemisphere, and several other peoples depart in greater or less measure from the five race-types.

From the earliest times, thinking men classed mankind in two or more divisions, of which the lower was regarded as ranking with brutes; and this view survives to-day among most primitive peoples. So the ancients divided the human genus into two species, *Homo sapiens* and *Homo brutus,* and held the former to possess and the latter to lack mind and soul. As exploration proceeded and knowledge of remoter peoples progressed during recent

centuries, scientific observers were more impressed by the resemblances among than by the differences between the human types, and were unable to discover or define the brutal species recognized by the ancients. Yet the question of affinity or relationship between man and lower organisms—and no greater question has arisen in all human history—refused to down, and reappeared in inquiries concerning the origin of man. In England Huxley and Darwin, and in Germany Haeckel, showed that the structure of the lowest humans more nearly resembles that of the highest quadrumanes (the 'four-handed' ape-like animals) than that of the highest humans, and from all known facts of both structure and development drew the inference that just as lower humans grow into higher types, so, in earlier times, some of the higher quadrumanes grew into lower humans; and much was said of the prospective finding of a 'missing link' combining more nearly than any known organisms the characters of human and quadrumane beings—a prophecy verified a quarter-century later by the discovery of *Pithecanthropus erectus* (erect monkey-man) in Java. The effect of the discussions and discoveries was to keep alive the idea of the close connection between man and the lower animals. Even before the discovery in Java, renowned anthropologists in Europe, and especially in Germany, noted a correspondence between the white, yellow, brown and black races of the old world and four leading types of quadrumanes, and suggested that the four human stocks were fundamentally distinct and had descended (or ascended) from the subhuman species. From this suggestion sprang the doctrine of polygenesis, which was opposed by those who preferred the theory of monogenesis, *i. e.*, the descent of all mankind from a single pair—the theory fostered by tradition and the doctrine of evolution, and originally held by all peoples. One effect of the ensuing discussion was to fix more clearly in all minds the classification of the peoples of the old world in four ethnic divisions or races; another was to keep in mind the idea of our ancestors that at least some men and the lower animals are closely akin. At every stage the views of the experts found their way into general thought, too often with some distortion; and partly for this reason all the world desires to see the lowest and remotest types of mankind, preferably in connection with those higher quadrumanes whose man-like features and movements form a source of endless interest to old and young alike.

In the early discussion of types of mankind and of human prototypes, little account was taken of the western hemisphere and the red race; when not altogether neglected, the aborigines of the American continents were commonly dismissed as emigrant offspring of an old-world stock admitted to the new world during prehistoric times over Behring Strait or some other transoceanic way. Especially during the later half of the nineteenth century the native tribes of the western hemisphere were brought under systematic observation, as were various other little-known peoples; and the observers were impressed by the number of aberrant or outstanding types—peoples like the Japanese, the Papuans and others who fail to conform to the conventional varieties or subspecies of *Homo sapiens*. The new world natives were easily defined as an additional variety or race, at first miscalled Indian in perpetuation of Columbus's error, then known generally as American, and afterward designated specifically as the Amerind type or race; yet even this race was found to present a considerable variety of physical types or subspecies, such as the Eskimo of the north, the so-called 'giants' of Patagonia, the light-skinned and almost flaxen-haired deni-

zens of certain mountain districts, and other peoples departing from the copper-tinted, black-maned and medium-size standards. In seeking to classify the local tribes, ethnologists were led to note industrial and social (*i. e.,* activital) features in addition to physical characters; and so began a system of classifying peoples on the basis of conduct, or in terms of what they *do* as human creatures rather than what they merely *are* as animal beings. In Europe there was a tendency to classify both living peoples and the relics of their precursors in terms of industrial development, and the stone age, the bronze age and the iron age were defined; in America the native tribes were classified first by the statesman-scientist Gallatin, and more fully by the scientist-statesman Powell, in terms of language; while some authorities classified so many as might be of the world's peoples according to their respective modes of social organization. An outcome of these essays was a system in which known peoples are combined in groups defined by distinctively human attributes; defined on the industrial basis, the groups were some time denoted (1) Paleolithic, (2) Neolithic, (3) Bronze and (4) Iron, and afterward and more broadly (1) Protolithic, (2) Technolithic, (3) Metallurgic and (4) Mechanical; and defined on the basis of social organization the peoples were grouped as (1) Maternal (or Avuncular), (2) Patriarchal, (3) Civic and (4) Democratic—the classes or groups in either case representing types of culture. A more important outcome was clearer recognition of the classific distinctness of man, coupled with living realization that, whatsoever his genetic affinities, man as an active and creative being rises far superior to any quadrumane or other animal prototype—for even the lowest human is an upright, two-handed and two-footed hairless body with his face to his fellows, while even the highest quadrumane (or quadruped) is but a groveling and bristly beast with his gaze and half-hands on the ground.

As the world's peoples and tribes were classed by race and culture jointly, it was soon seen that the types of culture really represent grades or stages in development, and also that the exercise of function and organ attending culture is a material factor in development; and hence that the course of human progress is not that of vital evolution alone, but one affected increasingly through the ages by activital forces arising in and with man himself. Like other beings of the animal realm, man is indeed a creature of birth and heredity and is influenced by environment; but through his collective activities, themselves the product and measure of culture, it becomes his chief function to modify environment and make conquest over lower nature. Even the primal factor of heredity passes partly (and increasingly) under social control; while the races occasionally blend, sometimes with so ill effect that the mixed family fades, yet often with so good result that to-day the world's peoples may be graded by ethnic complexity, the world's strongest blood being the world's most-mixed blood—and this blending reveals a law of convergent development (or intensification) extending the doctrine of polygenesis far beyond the four old-world types and suggesting that any or all of the more isolated tribes may represent primary stocks developed independently from fit local prototypes. So in the human realm the activities are paramount; and mankind may be classified either independently of or in conjunction with racial affinities in accordance with the activities and with the culture-stages defined in terms of the activities. Classified in this way, the peoples of the world fall into one or another of the four principal stages according to the degree of their advancement in some or all

of the activities; and it is the special merit of this classification that it is based on and in turn becomes an index to what the peoples habitually do, and hence to their aptitude and capacity for uniting with other peoples to promote human interests and the welfare of the world. Reduced to a scheme somewhat more consistent and arbitrary than might be found in any single continent, the activities and the principal stages of their development are as follows:

Activities.	*First Stage.*	*Second Stage.*	*Third Stage.*	*Fourth Stage.*
Arts,	Mimetic,	Symbolic,	Conventionalistic,	Idealistic.
Industries,	Imitative,	Divinative,	Constructive,	Inventive.
Laws,	Maternal,	Patriarchal,	Royal,	Social.
Languages,	Demonstrative,	Descriptive,	Associative,	Reflective.
Philosophies,	Zooic,	Theurgic,	Metaphysic,	Scientific.

When the world's peoples are classified by culture-grade, or in terms of progress from the lowest to the highest stages, it at once becomes manifest that they are arranged in accordance with mentality, knowledge and cerebral capacity, and measurably (with a few apparent exceptions) in accordance with general physical development, including strength, endurance and viability. It is especially significant that the distinctively human attributes of mentality and knowledge characteristic of each culture-grade are essentially alike among all the peoples pertaining to that grade, however remote their homes and however diverse their physical characters; for these correspondences reveal a comprehensive law now recognized as forming one of the five cardinal principles of science: the first of these is the indestructibility of matter, established by Lavoisier; the second is the persistence of force, discovered by Rumford and Joule; the third is the uniformity of nature, demonstrated by Tyndall and Spencer; the fourth is the development of species, brought to light by Darwin, Wallace and Huxley; the fifth is the responsivity of mind, suggested by Bacon and established by current researches in anthropology. The fundamental quality of these laws is such that the phenomena of nature (including those of the human realm) can not be interpreted without recognizing or at least postulating all of them; and that no other postulates are required for the interpretation of phenomena. The last-named law summarizes observation in such wise as to show that all mankind are closely bound in a potential if not actual community of thought, sentiment, aspiration and interest; and that, although the germ of mentality springs among the lower organisms, the psychic chasm separating man from the beasts is far wider than the physical break. Now when the world's tribes and peoples are classified by mind and knowledge, they fall into groups each characterized by those activital relations and motives peculiar to particular stages in the conjoint development of mental and manual processes; so that the final classification is a systematic arrangement of man and his works, both viewed in the broadest aspect and reduced to terms of works. Somewhat provisionally expressed in a conspectus, which like any other tabular arrangement is simpler and more arbitrary than the apparent chaos of unreduced facts might seem to demand, the better-studied classes (industries and industrial products, laws and institutions, and philosophies) may be represented as on p. 817.

Such are the leading classifications of mankind, by race, by genetic affinity, by activity, by stages of activital development, and by those steps in mental progress which during the ages have raised man from the

plane of the animal to his distinct and exalted position as a progressive conqueror of lower nature; and of such are man and the works of his hand and mind.

	Stage.	*Nature.*	*Relation.*	*Motive.*	*Type-product.*	
Industries.	I.	Protolithic,	Imitative,	Zoomimic,	Organ-adjunct,	Age of stone.
	II.	Technolithic,	Divinative,	Fatalistic,	Implement,	
	III.	Metallurgic,	Constructive,	Dynamic,	Tool,	Age of metal.
	IV.	Panurgic,	Inventive,	Kinetic,	Device,	
Laws.	I.	Maternal,	Adelphiarchal,	Zoocratic,	Clan,	Tribal society.
	II.	Paternal,	Patriarchal,	Theocratic,	Gens,	
	III.	Hereditary,	Oligarchal,	Aristocratic,	Kingdom,	National society.
	IV.	Electional,	Representative,	Democratic,	Republic,	
Philosophies.	I.	Zootheistic,	Instinctive,	Zoic,	Animism,	Age of myth.
	II.	Mythologic,	Subjective,	Theurgic,	Mysticism,	
	III.	Metaphysic,	Deductive,	Taxic,	Scholasticism,	Age of reason.
	IV.	Scientific,	Originative,	Telic,	Research,	

IV.

In the general view (in which the outlines are strengthened by classification), mankind are separated from all lower animals by certain small differences in size, form and structure, and by several large distinctions in habits of life; so that while the anatomist finds connecting links between simians and men, and while physiologists find their functions much alike, the student of broad anthropology defines man as the fire-making animal, and hence a user of cooked food and in other ways a creator of his own chief distinctions from the brutes—for all men known of themselves or from relics enslaved fire, while no lower animal masters this most potent of forces for the conquest of nature. So man stands out as a unique and dominant organism in the animal realm; and at the same time as a type or order of creative beings bound together by the power of control over natural forces for the common welfare.

The fire-maker, man, is distributed over all lands in a number of races and a still larger number of industrial and social varieties. Until recently all of both Americas was occupied by the Amerind race, and the red men were confined to these continents with their neighboring islands and a small section of adjacent Asia; nearly all of Africa was occupied by the African race, while the black men extended beyond this continent and a few neighboring islands only in a modified or negroid type; and the great Eurasian land-mass with its peninsulas and islands was the home of three races—the white men who lead and the yellow men and brown men who follow in that conquest of lower nature through the control of natural forces begun by the making of fire. The physical variations were least in America, more in Africa, most in Eurasia, where the physical break between highest and lowest (albeit spanned by numberless links) is greater than the chasm between the lowest human and the simian.

Until within a few centuries, most of the fire-making folk remained isolated, partly because of intervening seas, chiefly because of intervening gulfs of faith and custom; though some tribes were united in confederacies in which the chief bond was similarity in belief, the next similarity in speech, and the next similarity in work and industrial standards. In North America there were at the time of exploration some 1,200 or more tribes speaking some 75

totally distinct languages, each in several dialects; some of these were united in confederacies, like the Iroquois or Six Nations, and the Dakota or Seven Councilfires, and others lived in an inchoate feudal system, like the Montezuma group of Mexico; some tribes traced kinship in the female line and gave little thought to paternity, while about an equal number (including many of the wanderers and the most advanced sedentary folk) rested their social laws on paternal kinship; while the food-sources, implements, customs and habitations varied first with local peculiarities of habitat and in less degree with ancestral customs and migrations—the range running from corn-growing dwellers in stone, adobe and palm-wattled houses in the southwest, to hunting and fishing folk living in birch-bark wigwams in the east and thence to walrus-hunting occupants of snow-houses in the north and back to the buffalo hunters of the plains lodging in skin tipis in summer and earth-houses in winter, and thence to the salmon fishermen in single-log boats and hewn-slab houses (both consecrate unto carved and painted totems) in the northwest. In South America the fiducial and linguistic, social and industrial varieties were fully half as many; and the range from the stalwart Patagonians of the south to the puny woodsmen of the upper Orinoco, or from the knifeless Guayaqui savages to the aqueduct-building Inca kings, was even wider than that of North America. In Africa there were hundreds of tribes, speaking scores of distinct languages, of which some suggest the inconsequent chatter of Kipling's Bandarlog and really express some community of interest and feeling between lowly men and lower monkeys; and the tribes belong to two leading physical types, the shy and secretive aboriginal people of pygmy stature, and their full-size conquerors—sometimes stalwart and strong-limbed and of heroic stature, who long ago overspread the dark continent, bartering in iron and ivory and gold and often in slaves, and still live in a curious condition of mutual toleration and interdependence with the half-tamed little people. In Australia there were at least scores of negroid tribes, or Blackfellows, speaking a dozen or more distinct and notably primitive tongues, in which, as among some of the African pygmies, bird-like clicks and beast-like gutturals and monkey-like chatterings served in lieu of well-defined words, if not of entire parts of speech; though timid and generally peaceful, the tribes were often at bloody war, and though varying in physical form and feature, they were much alike in that few could count above five, none above seven or nine, and many stopped at three, in that their marriage laws were the most elaborate known, and in that many of the tribes merged sex-differences by ceremonial and surgical devices. On the miniature continent of New Zealand dwelt a composite people whose physical types were largely welded through similarity in esthetic and industrial and philosophic traits and customs, including the world's most elaborate system of heraldic genealogy in the form of facial tattooing; and in Oceanica most of the hundreds of islands and insular groups were inhabited by distinct tribes of two or three dominant physical types, each tribe commonly speaking its own language and pursuing its own special vocations with its own peculiar devices. In Asia there were the world's largest populations in three races, each including divers physical types; even the most homogeneous—the Mongolian—comprised a dozen or more divisions whose differences in speech and customs are not yet fully realized, partly because most of them are dominated alike by a vigorous Manchu dynasty and the terrifying Yellow Dragon; while the northern steppes were ranged by a dozen tribes of varying physique and speech and faith,

and the southern plains and foothills and jungles gave homes to literal hundreds of peoples, distinguished by physical type, by speech and faith, by caste, and by distinctive customs or clear territorial limits—and out of this hive of humanity sprang all the great religions the world has known. In the western fraction of the Eurasian land-mass there were, a half-century ago, several scores of tribes varying in physical type from the blond Dane and rufous Viking to the swart Iberian, speaking some dozens of distinctive tongues, adoring the shrines of countless nature-deities, and garnering germs of drama and letters and philosophy in the Walhalla of the north, the Elysium of the south, and the legion lost fanes and faiths of the middle lands. As the centuries sped, the tribes and tongues were partly blent through conquest by Aryan leaders who carried the cult and the color of the Caucasus northwestward, until by the middle of our era the shore-lands of the North Sea region throbbed with the most commingled blood and the most complex culture of the globe—then the human blood spanned the straits and rose pent in Britain to flow out in streams of compelling vigor, bridging all seas and reaching the remotest lands of the earth. All these—of the Americas and Africa, Australia and Oceanica, Asia and Europe—are among the peoples whose multifarious resemblances and differences appeal to every observer. They are alike in that all are fire-makers and so control thermic force for the weal of their kind through conquest over other nature; and with this suggestion of force as the primary factor in human affairs, the apparent chaos of humanity falls into order—for all are controlled by a few types of law, *i. e.*, of human force directed to human ends. The simplest type of law is that of control of the maternal family, under which the mother protects and directs her own children, appealing when needful to her own mother's strongest offspring, *i. e.*, her eldest brother; and this was the law of the less-developed aborigines of the Americas, Africa, Australia, Oceanica and Asia. More comprehensive is the law of control of the paternal family group, in which the physically stronger father guards and guides his own children and their offspring and dependents and those of his younger (*i. e.*, weaker) brethren; this law befits militancy and nomadic habit and the pastoral condition, and prevailed among the more advanced aborigines of America and Africa and many of the peoples of Oceanica and Asia. Still more comprehensive is the law of control of tenure; in arid lands, where the chief values inhere in springs and wells with adjacent lands, the control is essentially territorial, and in the east Mediterranean region the law gave demos and urbs—*i. e.*, the artificial group and the ancient city; in fruitful lands, where the chief values inhere in occupations and products and good-will, the law is essentially industrial, and in India yielded caste, and elsewhere trades and guilds, *i. e.*, overlapping artificial groups; and in broken country (including archipelagoes) the control is partly territorial and partly industrial, and in eastern Asia, most of Europe, and much of Oceanica, the law produced the province—*i. e.*, the more or less independent region of interdependent interests: and everywhere the basis of the law was economic and proprietary, and its observance reacted on the mind in such manner as to awaken recognition—especially in Greece and Rome and Kong (China) and more especially in Palestine—of the correlative interests of neighbors. While the law of control of tenure rose above the law of control of kindred in principle, the two ran together in practise so that the demos and urbs,

caste, the province, and the nation into which the urbs and province grew, were long controlled by family lines. Most comprehensive in applicability though simplest in ethical essence of all the fundamental types of law is that of control of the individual for the common good; in spirit this law rises above consanguinal and proprietary bonds and gives origin to government of the people, by the people, for the people. Thus, just as man, the fire-maker, rises above lower nature through control of external force, so does man, the law-maker, rise in successive groups above the lower of his own kind through control of the movements and motives reflecting his own internal force; and viewed in the light of law, the apparent chaos of uncounted thousands of the world's tribes and peoples, speaking unreckoned hundreds of tongues and pursuing innumerable vocations, is readily reduced to order.

Viewed as a law-maker, man reveals the stages of his own progress from a primal state to the condition of highest enlightenment—from the low level of the Australian Blackfellows or the African pygmies to the elevated plane of constitutional government. The law of the maternal family befits only a sparse population living largely in a state of nature, *i. e.*, small and isolated tribes of too low intelligence to recognize paternity or organize confederacies, to devise economic systems or to realize humanitarian motives and institutions; in this stage scores of living tribes still rest, while others (like the Muskwaki and Cocopa tribes, some of the Pueblo folk, and a number of Polynesian peoples) are just emerging from it; and its conditions are those under which all early men must have lived. The law of the paternal family is adapted to a denser population of industrial habits, *i. e.*, to large tribes entering on pastoral or agricultural life, and of intelligence sufficient to recognize paternity and to confederate with neighboring tribes for defense and offense, but not to frame economic systems or humanitarian institutions; the clearest early picture of this stage is that afforded by the children of Israel, and its best living illustrations are found among the aborigines of America; and the transition to the next higher stage is recounted in the earliest writings of many peoples and in the interpretations of these by modern genius—such as Fustel de Coulanges's 'Ancient City,' and Matthew Arnold's 'Light of Asia' and 'Light of the World.' The law of tenure is adjusted to still denser populations of commingled lineage, living in large and growing communities, *i. e.*, to industrial peoples gathering into cities and spreading over countries under the influence of intelligence sufficient to frame economic systems coupled with cults tending to foster humanitarian impulses and institutions; the development of this stage makes up most of the world's written history; and the movement toward the next is marked by nearly every popular revolt and by most cabinet revolutions of modern times. The law of the individual (or of constitutional citizenship) is framed for large and progressive industrial populations, *i. e.*, interdependent peoples of intelligence sufficient to recognize lineage and organize alliances, to create economic systems and frame humanitarian institutions, and to live and move in accordance with those principles of benevolence and tolerance and justice underlying all law. It is especially noteworthy (because too commonly overlooked) that in each stage the law is more formal and rigorous and better known in its letter than in the next higher stage, *i. e.*, that with each step in progress the control passes more and more from external domination toward internal force—the inner sense of right among men and

over nature. The way is long from benighted Blackfellow or savage Seri to the apostle of a kindly cult, the founder of a parliament, or the framer of a constitution; yet the world's laws are its mile stones.

Throughout its growth law is the expression of the best judgment and the highest intelligence of the time; hence it affords a measure of mental capacity, or of mind, in each stage of man's progress from savagery toward enlightenment. In each stage, too, the law is connected with arts and industries and with language and philosophy, expressing corresponding degrees of intelligence and affording other yet cognate measures of the mind of the time; and since the arts and industries, the languages and philosophies, are, like the law, the product of progressively expanding intelligence, it becomes clear that mind is the mainspring of man's progress, the special force underlying human development. In this view, the world's peoples are united in a solidarity of growing interdependence in which the less advanced may profit by association with the more advanced, and all may—indeed, must—proceed toward higher and higher intellectual advance, and toward more and more complete conquest over lower nature. In this view, too, the world's tribes and peoples illustrate steps in the development of intelligent man; and each is at once an object-lesson in the ill-written history of the human past and an object for beneficent example and effort—for man has no higher duty than that of mending the way of human progress. In this, as in every other view, the way is long from savage shaman to an Alexander or a Cæsar, from barbaric bandit to a Cromwell or a Washington, from rapacious elder-woman of a maternal clan to a Jeanne d'Arc or a Florence Nightingale—the way is long from a pygmy or an Ainu to a Roosevelt or a Francis: yet the way is so clear that even those who run may read aright if only the steps are shown in living examples.

V.

As the scope of the department was finally defined, it was necessarily adjusted to economic conditions arising from the curtailment, amounting to nearly 98 per cent., in the estimated needs.[2] It was affected also by the unprecedented breadth of scope of the Universal Exposition of 1904; for before the department was finally vitalized the voluntary participation of all the world's races and most of the nations was assured. The field of the department was materially affected, too, by the plans for the Philippine exposition, developed after the original estimates were submitted and before the department was finally created. Under the conditions, the scope of the department of anthropology came to comprise: (1) a representation of a limited number of the world's least-known ethnic types, *i. e.*, races or subraces defined on the physical basis; (2) a representation of a few of the world's least-known culture types, *i. e.*, of peoples defined on the activital (or mental) basis; (3) a representation of the principal methods and appliances used in research concerning the physical and mental characters of mankind; (4) a representation of typical evi-

[2] The estimate of Chairman Lehmann for maintaining the department of anthropology was $3,000,000; the appropriation was $60,000, or two per cent. of the estimate. The estimate of Chairman Chouteau for creating a department of history was $250,000; the appropriation was $15,000, or six per cent. of the estimate, the projected department being merged in the department of anthropology, where it was made one of six coordinate sections. The exposition appropriations were augmented by governmental appropriations for an Indian school and cognate exhibits amounting to $65,000. The final aggregate was thus $140,000, or 4.34 per cent. of the original estimates of $3,250,000 for anthropology and history.

dences of the steps and general course of human progress, including prehistoric vestiges, protohistoric relics and historical records; and (5) a representation of actual human development from savagery and barbarism toward enlightenment as accelerated by association and training.

1. The physical types first chosen for representation were those least removed from the subhuman or quadrumane form, beginning with the pygmy aborigines of Africa; in stature and proportions, in color and cranium, in form of face and function of limb, the little people of the African jungles are commonly considered to approach subhuman types more closely than any other variety of the genus *Homo*. Much like these are the negrito folk of interior Mindanao and other districts, brought to the fair for the Philippine exposition. The next physical type chosen was the Ainu of Hokkaido (or Yezo), the northern island of the Japanese Archipelago. The aborigines of Japan, the Ainu are of uncertain ethnic affinities (though found to comprise two subtypes divided on sex lines); while fairly developed in many respects, their small stature, their centripetal (or bodyward) movements, their use of the feet as manual adjuncts, their elongated arms and incurved hands, and their facility in climbing, approximate them to the quadrumanes and betoken a tree-climbing ancestry. Another type chosen early was the prognathous and long-armed and hence strikingly ape-like Australian Blackfellow; unhappily, one of the failures in negotiation resulting from the narrow monetary margin of the department intervened, and the exposition lost this most distinctive type of mankind not represented on the grounds—though the loss was mitigated in some measure by the ample representation from the same quarter of the globe in the Philippine exposition. Partly as a contrasting physical type, but chiefly to illustrate a variety of the Amerind race reputed since the time of Magellan to be gigantic and known as the largest type of primitive man, a Patagonian group (of the Tehuelche tribe) was selected; their stature probably exceeds the average of that of the most advanced peoples, and their bodily proportions and physical strength are almost equally heroic. Negotiations were completed also for exhibiting another native American group (the Seri Indians of Tiburon Island, Mexico), of nearly equal stature and superior strength and swiftness, though of less weighty frame, the supposed type of Swift's Brobdignagians, and the most savage tribe of North America; unfortunately, the difficulties and dangers of the expedition prevented the carrying out of the contract. Another Amerind group was selected chiefly to illustrate the consistent maintenance of two physical types in a single primitive folk—the Cocopa Indians, inhabiting the country about the mouth of the Rio Colorado in Mexico; in this tribe the men rank among the tallest and the women among the shortest of the North American natives. Other illustrations of the varying physical types among North American natives were exhibited in the Pawnee group (including Roaming Chief, probably the largest man on the grounds); the Dakota, or Sioux, group, representing the powerful and agile type of the northern plains; Pueblo folk, among the smallest of North American natives; dark-colored desert peoples (Pima and Maricopa), notable for agility and endurance, allied to the conquering Nahuatlan—or Aztec—tribe of Mexico; the short-hand and squat and flat-face natives of California (Pomo); and the singularly light-colored fisherfolk (Kwakiutl and Klaokwaht tribes) of humid Vancouver Island. None of the short and

well-rounded Eskimo type (of form befitting a frigid home and reflecting frequent frosting) were represented in the department by reason of the risk of life of Arctic folk attending the average St. Louis summer; though a concession concern on the grounds assumed the risk, to the interest and benefit of many thousands of visitors. Various other physical types were represented in connection with national pavilions or exhibits, or with concessions on the 'Pike'; and in the exhibit palaces and elsewhere within the exposition walls there were numerous typical representatives of the principal varieties of the Caucasian, Mongolian and Malayan races gathered from all the leading countries of Eurasia as well as from modern America, Africa, Australia and the larger islands of the Pacific region—and in addition to these, a constant stream of visitors from every quarter of the globe. On the whole, the gathering of ethnic types of the genus *Homo* was fairly representative, and might have been considered fully so save for the absence of the Australian aborigines, the natives of certain Pacific islands, and a few Asiatic tribes; even with these defects, the assemblage of physical types of mankind was unquestionably much more nearly complete than was ever before brought together.

2. The activital or culture types first considered comprised the lowest and least known; and the groups finally selected served to represent cultural and physical types combined. The failure of the Seri expedition and the negotiations for Australian Blackfellows was particularly regretted, since the former and some of the latter lack knife-sense and only use fire ceremonially, thus representing the lowest known culture; and to make up so far as might be this defect in the exhibits of the department, a protohistoric collection of relics and models (called the synthetic series), designed to illustrate the conquest of fire, the genesis of the knife and the development of the wheel, was brought together and installed in the anthropology building. The Seri savages of Tiburon and the Blackfellows of the Australian bush also exemplify the lowest known types of law and faith; the former are organized in maternal clans in which the clanmother (or elderwoman) is viewed as the vicar of an animal tutelary or beast-god, while her eldest brother is the executive or war-chief of the clan, and the purity of the tribal blood is maintained by most rigorous regulations concerning marriage; the latter have one of the most primitive yet complex social and fiducial organizations known, in which marriage is an elaborate arrangement, men are made to symbolize women by a severe surgery, and the control of movements and affairs is imputed to animal tutelaries. The African pygmies were selected in part to represent the maternal family (or clan) in which the intratribal control resides in an avuncular council, *i. e.*, the elder brothers of the clanmothers; though tribal law is partly overplaced by the control of full-size tribesmen, much as the industrial arts of the little people are affected by contact and barter with iron-making peoples ever since the iron age dawned probably in northern Africa some thousands of years ago.' The Ainu were selected to illustrate industries connected with bodyward movements, a primitive agriculture which has produced a distinctive form of millet, specialized architecture befitting a trying climate, a most primitive musical system, and a bear-cult—and in the hope of acquainting the world for the first time with the full law and faith of a little-known primitive folk; while the Patagonians were selected to illustrate the character and use of one of the most effective

known primitive devices (the bolas) as well as the maternal or clan organization, and also to reveal their own religious feeling and philosophy. The Cocopa Indians were selected to represent on the grounds a native American agriculture pursued unbrokenly since pre-Columbian times and still producing corn and other crops native to the western hemisphere, thereby illustrating such native lore and legend as those embalmed in Hiawatha; they also represent one of the most extravagant known mortuary customs, in which the goods of the decedent are distributed to non-relatives, while his house and his body are burned together, so that the people are perpetually impoverished and prevented from gathering in communities; and their marriage and puberty rites are elaborate, while the tribal law is in a state of transition from that of the maternal family to that of the paternal family. The Klaokwaht and Kwakiutl Indians were selected not merely as physical types but to illustrate a native type of house designed to fix the social organization and facilitate the maintenance of law, partly by virtue of elaborate totems (or animal tutelaries); this representation of northern Pacific coast culture-types being supplemented through cooperation with the Alaskan Commission. Several Amerind groups were selected partly to exhibit the leading native arts and crafts (such as pottery-making, basket-working, blanket-weaving and skin-dressing), partly to illustrate the organization of the paternal family (or gens); the Pawnee, Wichita, Navaho, Pima and Kickapoo groups constructed and occupied houses, each of a distinctive tribal type; while the Sioux tipis and other structures and fabrics exhibited sacred insignia betokening barbaric philosophies, of which some were displayed also in musical or dramatic terpsichorean ceremonies. The culture types at the fair, like the physical types, were greatly extended by the Philippine exposition, itself one of the most impressive exhibits of alien life and customs ever assembled; also in various state and national exhibits (among which the East India Pavilion and the Ceylon Tea House deserve note), and by several Pike concessions; while there were numerous collections of alien culture products, such as the Fred Harvey and Benham exhibits in the anthropology building, much of the collection forming the Queen's Jubilee Tributes, special exhibits in the Japanese, Chinese, Siamese, Belgian, Argentine and other pavilions, the Benguiat Museum, *et al.* Finally, the typical products of the most advanced art and industry filled the exhibit palaces with a richer and more cosmopolitan illustration of man's creative activity than the world ever saw before, while the attendant laws and languages and philosophies were set forth in other departments (especially education and social economy) and with unprecedented fullness in that series of legal and educational and scientific congresses through which the Universal Exposition of 1904 made its most impressive display of the power of man and the force of mind.

3. The methods and appliances used in anthropometry and psychometry (*i. e.*, in measuring the physical and mental characters of men) were selected with the purpose of utilizing the opportunities presented by the fair for observing and comparing the human types assembled on the grounds; while most of the apparatus and materials were obtained, and the installation and operation of the laboratories were made feasible, through the cooperation of educational institutions and manufacturers. It was in this branch of the department that the original or investigative work of the exposition culminated, and the conduct of the work was a constant source of

interest and attraction to visitors, while its results form a substantial contribution to knowledge.

4. The general view of human development opens a vista extending so far into the past and so widely into the field of man's activity that the recorded history of any particular province or people seems small in comparison; yet the history of a province or a people forms an effective introduction to the full history of mankind: accordingly, the written history of the Louisiana Purchase gave a keynote for the department as well as a motive for the exposition, and the exhibits were chosen and arranged in consonance with this view. Here, too, the work was made feasible by the cooperation of liberal institutions and individuals, chiefly historical societies and working historians. The nucleus was the collection of the Missouri Historical Society, illustrating by manuscripts and books, relics and portraits, maps and sketches, every important step in the development of the metropolis of the Louisiana Purchase Territory and in the growth of the commonwealth with which it has come up; and also illustrating by aboriginal relics the protohistoric development of the district from the times of aboriginal settlement, the building of earthen tumuli and temples, the growth of a primitive agriculture, and the advent of the bison and its hunters, into the period and through the centuries of discovery and acquisition and industrial conquest by white men. A supplementary illustration of development and conquest from the aboriginal condition to that of a great commonwealth comes from the Iowa State Historical Department; and collections serving to fill in the details of the general outline were exhibited by the Franco-Louisiana Society, the Louisiana State Historical Society, the Chicago Historical Society, and other co-operating exhibitors. The picture of progress so drawn was extended backward into the unwritten past of protohistory (or of relics interpreted in the light of observation on peoples of corresponding culture) partly by means of the synthetic series, partly by various exhibits representing the period of transition from Indian occupancy to white supremacy; this outline was then perfected by archeologic collections representing the prehistoric period—and the whole was given meaning and color by the presence on the grounds of living peoples with processes and products corresponding to nearly every step in progress betokened by the protohistoric and prehistoric relics. The typical evidences of human development assembled in the department were enlarged by numerous collections in exhibit palaces and pavilions, and especially in several of the state buildings, of which some were historical replicas, while many contained important historical and protohistoric material.

5. The relics and records indicate that a leading factor in man's development is progressive acculturation, or interchange and unification of knowledge. At first slow and inimical and effected chiefly through strife and conquest, the acculturation of the higher stages is rapid and amicable—schools replace armies, confederation supplants conquest, and the white man's burden of the ballad becomes the strong man's burden in the political family of nations as in the personal family of kindred. Long an accident of intertribal enmity, acculturation becomes, under the principles of constitutional government, an intentional and purposeful means of promoting the common weal; and the United States government has performed no worthier function than that of aiding our aboriginal landholders on their way toward

citizenship. The means and the ends of purposive acculturation as applied to the American aborigines, and the actual processes illustrated by living examples, were exhibited in the typical Indian school forming the most conspicuous feature of the department. Here parents still clinging to native customs and costumes delighted in the progress and achievements of their children in the arts and industries and even in the language and letters required by modern life; here the aboriginal maker of moccasins showed (and saw) the contrast between his craft and modern shoemaking; here the actual transformation from comfortless camp life into comfortable householdry was illustrated not only by every intermediate step, but by the actual passages of individuals and families from the one stage to the other during the exposition period; here the once bloody warrior Geronimo completed his own mental transformation from savage to citizen and for the first time sought to assume both the rights and responsibilities of the higher stage—here, indeed, was illustrated in epitome, and also in the actual progress accelerated by purposive cooperation, a considerable part of that course of intellectual development which raised man from dull-minded and self-centered tribal existence into the active and constructive and broad-minded life of modern humanity.

VI.

In a word, the motive and scope of the department of anthropology were to show our half of the world how the other half lives; yet not so much to gratify the untrained curiosity which leads even the child to look with wonder on the alien as to satisfy the intelligent observer that there *is* a course of progress running from lower to higher humanity, and that all the physical and cultural types of man mark stages in that course.

That the chief aim was gained may not now be claimed; though it can not be doubted that the assemblage of the world's peoples at the Universal Exposition of 1904 gave renewed and fuller meaning to the opinion of Pope that—

> The proper study of mankind is man.

The unbroken tally of visitors to the room containing the Victorian Jubilee Tributes exceeded a million, and the partial tallies in the anthropology building gave a tale approaching a million and a half; the estimated number of visitors to the Indian school building was above three millions, and it seems certain that over four million persons made more or less careful inspection of the alien camps and groups; while the current press items and weightier articles inspired by the anthropology exhibits are conservatively counted as forming at least a quarter and perhaps a third of all of the spontaneous publications pertaining to the fair. The full tale of attendance (total admissions, 19,694,855, not including Sundays; paid admissions, 12,804,616) comprised visitors from nearly every state and some foreign countries who came for the special purpose of seeing the African pygmies, the Ainu, the Filipinos, the Patagonians, or the assemblage of North American tribes; and a feature of the department was a formal 'field school of anthropology,' successfully conducted under the auspices of the University of Chicago, which may be considered the first definite step in cooperation for educational purposes between the permanent university and the temporary exposition. So the assemblage of human types was not only a source of attraction, but served serious ends.

W J McGee.

St. Louis Public Museum.

THE AMERICAN ORNITHOLOGISTS' UNION.

THE twenty-third congress of the American Ornithologists' Union convened in New York City, Monday evening, November 13. The business meeting of the fellows, and public sessions, November 14, 15 and 16, were held at the American Museum of Natural History. The final session, Thursday afternoon, was held at the Brooklyn Institute of Arts and Sciences.

Charles F. Batchelder, of Cambridge, Mass., was elected president; E. W. Nelson, of Washington, D. C., and Frank M. Chapman, of New York City, vice-presidents; John H. Sage, of Portland, Conn., secretary; Jonathan Dwight, Jr., of New York City, treasurer; Ruthven Deane, A. K. Fisher, Thos. S. Roberts, Witmer Stone, William Dutcher, Chas. W. Richmond, and F. A. Lucas, members of the council.

The ex-presidents of the union, Drs. J. A. Allen and C. Hart Merriam, and Messrs. William Brewster, D. G. Elliot, Robert Ridgway and Chas. B. Cory, are *ex-officio* members of the council.

Drs. Allen, Dwight, Merriam and Richmond, and Messrs. Brewster, Ridgway and Stone, were reelected 'Committee on Classification and Nomenclature of North American Birds.'

Walter K. Fisher, of Palo Alto, Calif., Professor Lynds Jones, of Oberlin, Ohio, and Wilfred H. Osgood, of Washington, D. C., were elected fellows. Five associates, Dr. Chas. W. Townsend, John E. Thayer, Rev. Wm. Leon Dawson, James H. Riley and Austin H. Clark, were elected to the class known as members, and seventy-one new associates were elected.

Mr. Witmer Stone had found among the archives of the Philadelphia Academy of Sciences, some unpublished letters of Alexander Wilson, and the extracts read from them were of historic interest—showing the disadvantages under which this pioneer ornithologist labored in his efforts to secure specimens.

A paper, which evoked much discussion, was read by Dr. J. A. Allen, on 'The Evolution of Species through Climatic Conditions.' He referred to certain geographic races described from the United States as illustrating the change of plumage and appearance of birds whose distribution covered a wide area.

Mr. Abbott H. Thayer, the eminent portrait painter, demonstrated his theory of the protective or disguising coloration of animals. Mr. Thayer has studied this subject from an artist's standpoint and believes 'that every animal which preys upon others or is preyed upon is an absolute picture of its environment at its time of greatest danger.' The elephant, he said, had no need of protective coloration.

Mr. C. Wm. Beebe, curator of birds at the New York Zoological Park, spoke of the collection under his charge and referred to many interesting experiments concerning feeding and surroundings, which he had been able to conduct in the park.

Dr. Thos. S. Roberts called attention to the great destruction of Lapland longspurs in southern Minnesota while migrating, March 13, 1904. A severe (moist) snowstorm occurred at the time and thousands of the birds were killed and injured by striking buildings, telegraph wires and the ice on different lakes. A conservative estimate of the number killed was 750,000, but he fully believes that 1,000,000 must have perished. Dr. Roberts illustrated his remarks with lantern slides, picturing the dead or injured birds as found in the snow in door-yards, parks and on various ponds. No other species appeared to be migrating with the longspurs.

During the sessions excellent lantern slides from photographs of birds in life were shown by Rev. H. K. Job, and Messrs. Chapman, Bowdish, Baily and Finley.

After a dinner at the Hotel Endicott, Tuesday evening, November 14, an informal reception was held for the members of the union and their friends, at the American Museum of Natural History.

At the closing session of the union, held at the Brooklyn Institute of Arts and Sciences, Mr. Geo. K. Cherrie had a paper on 'The Hoatzin and other South American Birds.' He traced the life history of different species and exhibited specimens of many of them. Mr. Wm. L. Finley spoke of the water birds of southern Oregon, illustrating what he said by many beautiful lantern slides.

The day following adjournment the members of the union visited the aquarium and the New York Zoological Park, and were received and entertained by Directors Hornaday and Townsend, and Curator Beebe.

Following is a list of the papers read at the sessions:

WITMER STONE: 'Some Unpublished Letters of Wilson and some Unstudied Works of Audubon.'

J. A. ALLEN: 'The Evolution of Species through Climatic Conditions.'

ELON H. EATON: 'Summer Birds of the Mt. Marcy Region in the Adirondacks.'

FRANK M. CHAPMAN: 'Pelican Island Revisited.' Illustrated by lantern slides.

B. S. BOWDISH: 'Some Breeding Warblers of Demarest, N. J.' Illustrated by lantern slides.

WILLIAM L. FINLEY: 'Notes on Wing Movements in Bird Flight.' Illustrated by lantern slides.

J. DWIGHT, JR.: 'The Status of Certain Species and Subspecies of North American Birds.'

HERBERT K. JOB: 'Wild-fowl Nurseries of Northwest Canada.' Illustrated by lantern slides.

C. J. PENNOCK: 'Andreæ Hesselius, a Pioneer Delaware Ornithologist.'

WITMER STONE: 'The Probability of Error in Bird Migration Records.'

WITMER STONE: 'Some Observations on the Applicability of the Mutation Theory to Birds.'

HENRY OLDYS: 'The Song of the Hermit Thrush.'

FRANK M. CHAPMAN: 'Impressions of English Bird-Life.' Illustrated by lantern slides.

WILLIAM L. BAILY: 'Exhibition of Lantern Slides.'

THOMAS S. ROBERTS: 'A Lapland Longspur Tragedy.' Illustrated by lantern slides.

WILLIAM L. BAILY: 'Similarity of the Birds of the Maine Woods and the Pocono Mountains, Pa.'

WELLS W. COOKE: 'Discontinuous Breeding Ranges.' Illustrated by lantern slides.

ABBOTT H. THAYER: 'The Principles of the Disguising Coloration of Animals.' Illustrated with experiments and slides.

C. W. BEEBE: 'The Collection of Birds in the New York Zoological Park.'

DR. MONTAGUE R. LEVERSON: 'Contribution to the Natural History of the English Cuckoo, with a Review of the Literature on the Subject.'

DR. J. DWIGHT, JR.: 'Plumages and Status of the White-winged Gulls of the Genus *Larus*.'

ARTHUR T. WAYNE: 'Contribution to the Ornithology of South Carolina, Pertaining Chiefly to the Coast Region.'

O. WIDMAN: 'Should Bird Protection Laws and their Enforcement be in the hands of the National Government?'

GEORGE K. CHERRIE: 'The Hoatzin and other South American Birds.' With exhibition of specimens.

WILLIAM L. FINLEY: 'Among the Water Birds of Southern Oregon.' Illustrated by lantern slides.

The next annual meeting will be held in Washington, D. C., commencing November 12, 1906.

JOHN H. SAGE,
Secretary.

SCIENTIFIC BOOKS.

SOME RECENT TEXTS IN GENERAL AND ORGANIC CHEMISTRY.

Conversations on Chemistry. By W. OSTWALD, Professor of Chemistry in the University of Leipzig. Authorized translation by ELIZABETH CATHERINE RAMSAY. Part I., General Chemistry. New York, John Wiley & Sons. Pp. v + 250. 12mo. $1.50.

Descriptive Chemistry. By LYMAN C. NEWELL, Ph.D. (Johns Hopkins), Professor of Chemistry, Boston University. Author of 'Experimental Chemistry.' Boston, D. C. Heath & Co. Pp. vi + 590. 12mo. $1.20.

The Elements of Chemistry. By M. M. PATTISON MUIR, M.A., Fellow and Prælector in Chemistry at Gonville and Caius College, Cambridge, Philadelphia, P. Blakiston's

Son & Co. Pp. xiv + 554. 8vo. $3.50 net.

A Compendium of Chemistry, Including General, Inorganic and Organic Chemistry. By Dr. Carl Arnold, Professor of Chemistry in the Royal Veterinary School of Hanover. Authorized translation from the eleventh enlarged and revised German edition by John A. Mandel, Sc.D., Professor of Chemistry, Physics and Physiological Chemistry in the University and Bellevue Hospital Medical College. New York, John Wiley & Sons. Pp. xii + 627. 8vo. $3.50.

A Text-book of Organic Chemistry. By William A. Noyes, formerly Professor of Chemistry in the Rose Polytechnic Institute, now Chief Chemist in the Bureau of Standards, Washington, D. C. New York, Henry Holt & Co. Pp. xvii + 534. 12mo. $1.50.

Praktische Uebungen zur Einführung in die Chemie. Von Dr. Alexander Smith, Professor für Chemie an der Universität Chicago. Nach einer vom Verfasser besorgten Umarbeitung der zweiten amerikanischen Auflage ins Deutsche übertragen von Professor Dr. F. Haber und Dr. M. Stoecker. Karlsruhe, Druck und Verlag der G. Braunschen Hofbuchdruckerei.

Experiments Arranged for Students in General Chemistry. By Edgar F. Smith, Professor of Chemistry, University of Pennsylvania, and Harry F. Keller, Professor of Chemistry, Central High School of Philadelphia. Fifth edition, enlarged, with 40 illustrations. Philadelphia, P. Blakiston's Son & Co. Pp. 92, with blank pages interbound. 12mo. $0.60.

Conversations on Chemistry.—This is the authorized translation of the first volume of Ostwald's 'Die Schule der Chemie,' which was published in 1903. The book has attracted wide attention, not only because of the renown of its author, but also because of the novel way chosen for presenting the subject. In his 'Grudlinien,' translated under the title of 'The Principles of Inorganic Chemistry,' Ostwald has presented the subject to the mature student. In his 'Conversations,' however, the author addresses himself to distinctly elementary pupils. The form chosen for presenting the subject is the dialogue, 'because after several attempts it appeared to me the most suitable; moreover, I have come to the conclusion that it occupies no more space than an ordinary description, while the impression it makes is much more penetrating and lively.' The conversation takes place between the master and the pupil. The topics of conversation include such subjects as substances, properties, solutions, melting and freezing, density, compounds, elements, oxygen, hydrogen, nitrogen, air—thirty topics in all. The following will give an idea of the method of discussion:

Master. Have you ever looked at a candle burning? Yes? Then describe to me what you saw.

Pupil. When you light a candle it burns down till it is all gone, and during this it has a hot, bright flame.

M. Right. What is necessary for burning?

P. Well, the candle.

M. Nothing else?

P. Not that I know of.

M. If you put the burning candle in water—

P. It goes out.

M. Why? What is different from before?

P. It has no more air.

The master then shows by simple experiments and judicious questions that air is necessary for the combustion and that carbon dioxid is formed in the process. The interest and enthusiasm of the pupil lead to many expressions that the translator no doubt had difficulty in rendering in English; thus when the master explodes a mixture of hydrogen and air, the pupil exclaims, 'By jove! what a thundering crack!' and again when the soap bubble inflated with hydrogen rises like a balloon, 'Oh, how ripping!'

The book is not adapted as a text for students; neither could teachers follow it literally. On the other hand, no teacher could read it carefully without gaining much that would be helpful to him in presenting the subject of elementary chemistry. No one who has the knowledge of the 'master' and the happy way of presenting it could fail to attract and interest the pupil. The chief value of the book must lie, therefore, in showing

something of the spirit and the methods best adapted for arousing the interest of young pupils in elementary science.

The second and final volume of the 'Die Schule der Chemie' appeared in 1904. In this volume the author discusses in the same style some of the more important elements and compounds. The translation of this is promised soon.

Newell's Descriptive Chemistry.—This book is true to its title—a descriptive chemistry. In the preface the author tells us that the 'book is intended for teachers who wish to emphasize the facts, laws, theories and applications of chemistry.' The order of treatment is that which has recommended itself to most authors of elementary texts, no attempt being made to follow strictly the periodic classification; in fact the discussion of the periodic law is postponed until the next to the last chapter in the book. The book is divided into two parts. The first part consists of 436 pages of text with an appendix of 15 pages. The second part (100 pages) contains the experiments. There is an index of 36 pages.

The general subject is treated in a comprehensive and interesting way. As the title would indicate, considerable space is given to the applications of chemistry. Thus nearly four pages are devoted to the manufacture of coal gas. The theoretical side, however, has not been neglected. The experiments are well chosen and are such as can be performed readily by elementary students. But few quantitative experiments are included. At the end of each chapter is a complete list of questions on all the topics discussed in the chapter.

The book is a companion volume to the author's 'Experimental Chemistry.' These two books, 'The Experimental Chemistry' and 'The Descriptve Chemistry,' seem to the reviewer to represent rather the extreme views of the advocates of the two methods of teaching chemistry. It is a question whether the good features of the two could not be combined, making a text which would meet the approval of a larger number of teachers. It is doubtful whether the complete lists of questions appended to each chapter add to the value of the book. It is certain that many students will turn at once to these lists and the book then degenerates into a sort of catechism.

A number of full-page cuts of distinguished chemists add to the appearance and value of the book.

Muir's Elements.—According to the preface, the objects of the book are: "To present some of the fundamental facts, generalizations, principles and theories of chemistry, lucidly, methodically and suggestively, to train the student in a few of the methods of investigation and reasoning which have been used in the past and some of the methods which are used to-day, for discovering and coordinating the connections between the properties and the compositions of systems of homogeneous substances; to attempt to lay the foundations of chemistry in such a way that the student may be prepared for going more deeply into the science, if he wishes so to do." The author also adds: "I hope I have not merely added one more illustrated catalogue of chemical odds and ends to the many which have already appeared under the title of 'A Text-book of Chemistry.'" Surely the author has 'hitched his wagon to a star.'

The book is divided into twenty-six chapters. Of these the first five are devoted to the definitions of chemical terms, the statement of the laws of combination, the determination of the combining weights of elements and the reacting weights of compounds and the representation of interactions by means of formulas and equations. Then follows a study of hydrogen, oxygen, nitrogen, sulphur, potassium, sodium, iron (note the order) and other elements, with chapters interspersed on oxidation and reduction, the molecular and atomic theory, the periodic law and the measurement of thermal values of chemical changes.

The text is similar to Ostwald's 'Grudlinien' in that the molecular and atomic theories are given comparatively little prominence. Thus while the first half of the book abounds in formulas and equations, these are all explained from the standpoint of combining weights and reacting weights, the latter term being defined as 'the quantity by weight of the com-

pound denoted by the expression of its composition by the smallest possible whole numbers of combining weights of the elements which form it.' The atomic theory is first mentioned on page 341, Avogadro's law on page 352. Considerable prominence is given to energy changes accompanying chemical changes. Many references to and quotations from the writings of Dalton, Davy and others impart an historical flavor to the book. An appendix of fourteen pages treats of the general characters of the eight groups of elements.

The author has certainly been successful in not producing 'a catalogue of chemical odds and ends.' Whether the method of treatment is an improvement upon the more common methods is a question that must be decided by trial in the lecture room.

Noyes's Organic Chemistry.—The author states in his preface that "an attempt is here made to present the fundamental principles of organic chemistry for the use of those beginning the subject. The most radical departure from the method of treatment adopted in other books treating of the same subject consists in the dropping of the division into 'fatty' and 'aromatic' compounds and in the adoption of what appears to the author a more fundamental and logical classification."

The subject-matter is divided into twenty-five chapters. Of these, chapters I. and II. deal with purification and analysis of compounds, the determination of molecular weights and formulas and a general discussion of the physical properties of organic compounds. Chapters III. to VIII., inclusive, treat of the hydrocarbons. In chapter IX. is given the classification of the derivatives of the hydrocarbons. The remaining chapters are devoted to a discussion of these derivatives.

The most striking feature of the book undoubtedly lies in the fact that the time-honored classification of the compounds into the so-called 'fatty' and 'aromatic' classes is set aside and the corresponding members of each class discussed together. While this is a very radical departure, there is no question but that the method chosen is a logical one and at least well worth a trial in the lecture room. The book bears unmistakable evidence that its author has been an enthusiastic worker in the field of organic chemistry and that he has given to the student, in so far as the space would permit, a clear and comprehensive discussion of the science as it exists to-day. It is a question whether some of the general reactions discussed might not have been illustrated by simpler examples. As the author states in his preface, however, 'no two authors would make the same selection, and that here given is doubtless open to just criticism at some points.'

To write an elementary text in a science which includes a study of over 100,000 compounds besides a number of growing theories is not an easy task, and the person who does this successfully is certainly deserving the commendation of the teachers of the science. Noyes's text must be regarded along with Remsen's as the best of modern elementary texts of organic chemistry.

Smith's Praktische is the German translation of his well-known 'Laboratory Outline of General Chemistry,' which is undoubtedly one of the best of the 'laboratory outlines' for mature students.

Smith and Kellar's Experiments has deservedly reached its fifth edition. The experiments are well chosen to illustrate the principles of chemistry. A number of quantitative experiments are included.

WILLIAM MCPHERSON.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Experimental Zoology for November, 1905. T. H. Morgan ('Polarity' considered as a phenomenon of gradation of material) discusses in the light of some new experiments with the hydroid Tubularia the so-called 'polarity' of organisms, as seen especially in the phenomenon of regeneration. The author advances the hypothesis that organic 'polarity' is an expression of the gradation of the organ-forming substances present in the adult. These substances are traceable to the egg, which owes its development in part to their localization. The phenomena of development and of regeneration are thus brought under a common point of view. H. S.

Jennings, in a paper entitled 'Modifiability in Behavior. I. Behavior of Sea Anemones,' shows that the course of the internal physiological processes, the past experience of the organism, and various other internal factors, partly determine the behavior of sea anemones and modify fundamentally their reactions to external stimuli. In a second paper entitled 'The Method of Regulation in Behavior and in other Fields,' the same author gives a general outline of the method of regulation shown in the behavior of the lower organisms. E. B. Wilson's 'Studies on Chromosomes,' No. II., deals with some of the specific classes of chromosomes in the *Hemiptera,* and their history in the maturation phenomena, and is intended to clear the ground for a study of the sexual relations of the chromosome groups. An appendix records facts, determined by later observations, that give complete confirmation of the theoretic expectations regarding the sexual relations, stated in the general discussion. (See issue of SCIENCE for October 20, 1905.) Chas. W. Hargitt (Variations among Scyphomedusæ), gives a detailed study of the variations found in *Aurelia flavidula,* with a view to determine their relations to the problems of adaptation and natural selection. Lorande Loss Woodruff (An Experimental Study of the Life-History of *Hyptrichous Infusoria*), describes five cultures, all of which passed through cycles of greater and less general vitality as measured by the rate of division. Recovery from a period of extreme depression was effected by extract of beef. Minor fluctuations occurred which are termed 'rhythms' and are to be clearly distinguished from cycles. A description is given of the cytoplasmic and nuclear changes during the life-cycle, as well as of a series of experiments on the effect of salts on the division rate.

SOCIETIES AND ACADEMIES.

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES.

There will meet at New Orleans:

The American Association for the Advancement of Science.—The week beginning on December 28. Retiring president, Professor W. G. Farlow, Harvard University; president-elect, Professor C. M. Woodward, Washington University, St. Louis, Mo.; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Professor C. A. Waldo, Purdue University, Lafayette, Ind.; secretary of the council, Dr. John F. Hayford, U. S. Coast and Geodetic Survey, Washington, D. C.

Local Executive Committee.—Honorary president, President E. B. Craighead, Tulane University; executive president, Professor George E. Beyer, Tulane University; secretary, Henry M. Mayo, The New Orleans Progressive League; treasurer, Mr. Clarence F. Low, of the Liverpool, London and Globe Insurance Company.

Section A, Mathematics and Astronomy.—Vice-president, Dr. W. S. Eichelberger, U. S. Naval Observatory, Washington, D. C.; secretary, Professor L. G. Weld, University of Iowa, Iowa City, Iowa.

Section B, Physics.—Vice-president, Professor Henry Crew, Northwestern University, Evanston, Ill.; secretary, Professor Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Section C, Chemistry.—Vice-president, Professor Charles F. Mabery, Case School of Applied Science, Cleveland, Ohio; secretary, Professor Charles L. Parsons, New Hampshire College of Agriculture, Durham, N. H.

Section D, Mechanical Science and Engineering.—Vice-president, Professor F. W. McNair, Houghton, Mich.; secretary, Professor Wm. T. Magruder, Ohio State University, Columbus, Ohio.

Section E, Geology and Geography.—Vice-president, Professor Wm. North Rice, Wesleyan University, Middletown, Conn.; secretary, Dr. Edmund O. Hovey, American Museum of Natural History, New York, N. Y.

Section F, Zoology.—Vice-president, Professor Henry B. Ward, University of Nebraska, Lincoln, Nebr.; secretary, Professor C. Judson Herrick, Denison University, Granville, Ohio.

Section G, Botany.—Vice-president, Dr. Erwin F. Smith, U. S. Department of Agriculture, Washington, D. C.; secretary, Professor F. E. Lloyd, Teachers College, Columbia University, New York, N. Y.

Section H, Anthropology.—Vice-president, Dr. George Grant MacCurdy, Yale University, New Haven, Conn.; secretary, George H. Pepper, American Museum of Natural History.

Section I, Social and Economic Science.—Professor Irving Fisher, Yale University, New Haven, Conn.; secretary, Dr. J. F. Crowell, Bureau of Statistics, Washington, D. C.

Section K, Physiology and Experimental Medicine.—Vice-president, Professor Wm. T. Sedg-

wick, Massachusetts Institute of Technology, Boston, Mass.; secretary, Dr. Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

At New Orleans in conjunction with the American Association for the Advancement of Science there will meet:

The American Chemical Society.—President, F. P. Venable, University of North Carolina; secretary, Dr. William A. Noyes, the Bureau of Standards, Washington, D. C.

The Botanical Society of America.—January 4. President, Professor R. A. Harper, University of Wisconsin; secretary, Dr. D. T. MacDougal, N. Y. Botanical Garden, Bronx Park, New York City.

The Association of Economic Entomologists.—January 1, 2, 3. President, Professor H. Garman, Lexington, Ky.; secretary, Professor H. E. Summers, Ames, Iowa.

The Society for Horticultural Science.—December 27. President, Professor L. H. Bailey, Cornell University; secretary-treasurer, V. A. Clark, Phœnix, Ariz.

The American Mycological Society.—January 1–4. President, Chas. H. Peck, state botanist, Albany, N. Y.; secretary, C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

The Southern Society for Philosophy and Psychology. President, Professor J. Mark Baldwin, The Johns Hopkins University; secretary, Professor E. F. Buchner, University of Alabama.

At Ann Arbor will meet:

The American Society of Naturalists.—President, Professor William James, Harvard University; secretary, Professor W. E. Castle, Harvard University. President (Central Branch), Professor H. H. Donaldson, University of Chicago; secretary, Professor W. J. Moenkhaus, Indiana University. The Eastern Branch will not meet this year.

The American Society of Zoologists (Eastern and Central Branches).—December 28, 29, 30. President (Eastern Branch), Professor W. E. Castle, Harvard University; secretary, Professor H. S. Pratt, Haverford College. President (Central Branch), Professor Frank R. Lillie, University of Chicago; secretary, Professor C. E. McClung, University of Kansas.

The Society of American Bacteriologists.—December 28, 29. President, Professor Edwin O. Jordan, University of Chicago; secretary Professor Frederic P. Gorham, Brown University, Providence, R. I.

The American Physiological Society.—December 27, 28. President, Professor W. H. Howell, the Johns Hopkins University; secretary, Professor Lafayette B. Mendel, New Haven.

The Association of American Anatomists.—December 27, 28, 29. President, Professor Charles S. Minot, Harvard Medical School; secretary, Professor G. Carl Huber, 333 East Ann St., Ann Arbor, Mich.

The Society for Plant Morphology and Physiology.—December 27, 28, 29. President, Professor E. C. Jeffrey, Harvard University; secretary, Professor W. F. Ganong, Smith College, Northampton, Mass.

At New York City will meet:

The Astronomical and Astrophysical Society of America.—December 28. President, Professor Simon Newcomb; secretary, Professor Geo. C. Comstock, Washburn Observatory, Madison, Wis.

The American Physical Society.—December 29, 30. President, Professor Carl Barus, Brown University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Mathematical Society.—December 28, 29. President, Professor W. F. Osgood, Harvard University; secretary, Professor F. N. Cole, Columbia University.

The American Paleontological Society.—December 27, 28. President, Professor William B. Scott, Princeton University; secretary, Dr. Marcus S. Farr, Princeton University.

At Cambridge will meet:

The American Psychological Association.—December 27–29. President, Professor Mary Whiton Calkins, Wellesley College; secretary, Professor Wm. Harper Davis, Lehigh University.

The American Philosophical Association.—December 27–29. President, Professor John Dewey, Columbia University; secretary, Professor John Grier Hibben, Princeton University.

At Ithaca will meet:

The American Anthropological Association.—December 27–29. President, Professor F. W. Putnam, Harvard University; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

At Ottawa will meet:

The Geological Society of America.—December 27, 28, 29. President, Professor Raphael Pumpelly; secretary, Professor Herman L. Fairchild, Rochester, N. Y.

THE BIOLOGICAL SOCIETY OF WASHINGTON.

THE 404th regular meeting of the Biological society was held October 28, 1905, with President Knowlton in the chair and 66 persons present. Mr. A. A. Doolittle presented a specimen of a peculiar form of fruit of walnut (*Juglans*) recently picked up by one of the high school pupils. Dr. A. D. Hopkins made note of two species of bark beetles so destructive of forest trees in Colorado that they render the forests more liable to fire because of the increased amount of dead and fallen timber. Dr. H. M. Smith noted the unusual occurrence of so many woodcock in the vicinity of Washington, especially on the Maryland side of the Potomac River between Washington and Indian Head. Dr. T. S. Palmer reported the bagging of 96 woodcock. Dr. Smith also noted the capture of a reed bird near Washington a few days since in the spring plumage of the bobolink. Dr. Knowlton reported the presence of wild geese, recently, in a garden at Laurel, Maryland; and also of a loon, the latter apparently wounded. Mr. H. W. Oldys presented, with whistled notes, a song of a hermit thrush recently under his observation.

For the first paper of the evening, on 'The Changes in the Bird Life on an Indiana Farm during Recent Years,' Dr. B. W. Evermann gave a list of the birds (48 species) which he observed during a week's stay (June 25 to July 1) on a farm in Carroll County, Indiana, and called attention to some of the changes in the bird life of that region in recent years. Attention was called to the physical conditions existing there thirty years ago—the heavy forests, the large swamps, the numerous smaller ponds—and these were contrasted with present conditions—forest largely cut off and the underbrush cleared away, the swamps drained and now in corn and cabbage, and the ponds all gone, and with them practically all the swamp-loving birds as well as those that love the forest. These changes are especially noticeable with the crow blackbirds, red-shouldered blackbirds, herons, bitterns, golden swamp warblers and the like; also the woodpeckers, bluebirds, tanagers, orioles and warblers. Discussion followed by Mr. Kallock.

The second paper was by Dr. L. O. Howard, giving 'Some Notes on the Yellow-fever Mosquito.' Discussion followed by Dr. Carroll, of the U. S. Army, who particularly noted that *Stegomya* bites negroes in Washington, though rarely in yellow-fever countries. Mr. Schwarz noted that the mating *Stegomya* has not been seen by him in Cuba, and that none of this genus are flying at the time of day, about five in the afternoon, at which *Culex pipiens* is abundant and mating.

For the third paper on 'An American Cretaceous Chimæroid Ovicapsule,' Dr. Theodore Gill exhibited the impression of a Cretaceous chimæroid ovicapsule from the vicinity of Laramie, Wyoming, originally submitted to him for identification by Dr. Frank H. Knowlton and now in the custody of Dr. T. W. Stanton, in the National Museum. It is the first of the kind noticed in the United States and is interesting on account of its resemblance to the ovicapsules of chimæroids of the family of Harriottidæ found in the deep seas of the Atlantic and Pacific. It is also important as an indication of the structural features of the chimæroids of the Cretaceous period. The previously known ovicapsules of chimæroids of Mesozoic age had been obtained from Jurassic beds of Würtemberg and indicated a relationship of their makers to the callorhynchids. This paper was discussed by Dr. Stanton.

E. L. MORRIS,
Recording Secretary.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 607th meeting was held on November 18, 1905.

Mr. Burbank spoke informally on the recent observations on terrestrial magnetism in Labrador; disturbances in the declination amounting to 1° 50″ were noted.

Mr. E. Buckingham presented a paper on 'The Capillary Motion of Water in Soils.'

Previous work by the speaker showed that the rate at which carbonic acid and air mix by diffusion through layers of soil is approximately proportional to the square of the porosity of the soil. Experiments on water vapor and air appear to give the same result. The experiments also showed that the loss of water

by direct evaporation from depths of over two inches in the rock must in general be insignificant from an agricultural point of view, hence if the capillary flow of water upward can be nearly stopped an inch or two below the surface by the formation of a dry surface layer, the wasteful loss of water by evaporation will be much decreased.

Laboratory experiments by Mr. J. O. Belz in the physical laboratory of the Bureau of Soils, in which arid and humid climatic conditions were simulated, showed that such a dry layer may be formed naturally under very arid conditions. A very rapid initial evaporation forms a dry surface layer, and the rate of evaporation then falls off very greatly, the result being that in the long run the total loss of water from the soil is less under very arid conditions than under humid conditions. Under arid conditions, a soil has thus an automatic tendency to protect itself from the great loss of water which would at first sight be expected to occur under such conditions.

Mr. Briggs applied these principles to the conditions of desert plants.

Mr. J. C. Blake then read a paper on 'The Electrical Behavior of Colloidal Mixtures.'

The early work of Quincke and others on the migration of visible particles was shown to be in accord with the recent work on 'Colloids.' The rate of migration of visible particles as well as of colloids is almost identical with that of the common ions in electrolytic solution. It was shown that each colloidal particle is probably accompanied by an ion, which causes the migration of the particle, the ion and colloidal particles being surrounded by an electric double layer. The absolute conductivity of the colloidal material in a colloidal mixture agrees with the idea that each colloidal particle carries the ionic charge. Hence colloidal mixtures are to be regarded as true solutions largely ionized, one of the ions being associated with the colloid.

CHARLES K. WEAD,
Secretary.

THE NEW YORK ACADEMY OF SCIENCES. SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

AT a meeting held November 27, 1905, in conjunction with the New York Section of the American Psychological Association, Professor Woodbridge occupying the chair, Professor Robert MacDougall was elected chairman for the coming year, and Professor R. S. Woodworth secretary. The following papers were presented:

Smell Discrimination of Students: WILL S. MONROE.

A statistical inquiry into the ability of 255 girls to recognize odors showed that, on the average, 6.72 out of a set of 20 common odors, chiefly essential oils, were correctly named. Those most often identified were wintergreen, camphor, peppermint, vanilla and cloves; those least often, hemlock, bergamot, asafœtida, wormwood and lavender. A census of odor names showed that some of those least often recognized, as lavender, were believed to be familiar. The fact is simply that people do not know as many odors as they suppose.

Linguistic Standards: FREDERIC LYMAN WELLS.

The speaker contended that the current standards of 'good use,' based as they are on the individual introspection of rhetoricians, or on a reactionary adherence to selected historical models, were not adequate to the changing needs of a language. By the application of statistical methods, it is possible to obtain standards that are free from the arbitrariness of one-man introspection, and also furnish, in the 'probable error,' a measure of their own validity. A statistical study of the relative 'force' of synonyms yielded results having a very small probable error, which nevertheless did not agree with any of the definitions of force which the introspective grammarians have laid down.

A Threshold Study of the Reading Pause: F. M. HAMILTON.

The author showed how the tachistoscopic method could be adapted to the reading not only of isolated words, but also of sentences and paragraphs; to the analysis of processes at the threshold of word recognition; and to the study of the marginal field of perceptual regard. Light is thrown by these experiments upon the questions of literal reading, reading cues, value of context, etc.

Vision and Localization during Rapid Eye Movements: R. S. WOODWORTH.

The author sought to show that vision occurs during movements of convergence, and also in rapid 'jumps' of the eye from one fixation point to another. The latter fact is best shown by the clear vision of a rapidly moving object that occurs when the eye moves in the same direction and with the same speed as the object. This can not be explained, as has been attempted, by supposing that only an after image of the impression received during the eye jump comes to consciousness, for the object is not only seen, but correctly localized in space.

The Measurement of Scientific Merit: J. MCKEEN CATTELL.

A method was explained by which it was possible to select a group of the leading 1,000 men of science of the United States for the study of individual differences and by which degrees of scientific merit could be measured. The more eminent scientific men are distributed in accordance with the positive half of the curve of error, the first hundred differing among themselves about as much as the next two hundred or the last seven hundred. Data were also given in regard to the distribution of scientific men, including their birthplace, their place of residence and the institutions with which they are connected.

Temperament as Affecting Philosophic Thought: BROTHER CHRYSOSTOM.

It was urged that the temperament of a philosopher was so potent a factor in determining his emphasis of certain doctrines, his introduction of illogical views and his personal influence in the founding of his school, that it must be considered in order to understand his philosophy. Heredity, environment, race, epoch, the personality of the philosopher and of the master who first influenced him, were mentioned as elements in the temperamental complex that determines the cast of his thought.

Are Mental Processes in Space? W. P. MONTAGUE.

The paper consisted in a protest against the current view of mental processes as real occurrences that occur nowhere, and an attempt to show that they could exist in space without being either punctiform or figured (compare sounds and odors), and without displacing matter or being wedged into the spaces between material particles (compare stresses, velocities and accelerations). Potential energy, like mental action, exists in space without being visible and without displacing matter. Both are localized intensive states; and it was suggested that mental processes may be forms of potential energy into which the kinetic energy of the nerve currents must be transformed in order to be redirected.

R. S. WOODWORTH,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE THEORY OF ISOLATION AS APPLIED TO PLANTS.

PRESIDENT JORDAN, in his opportune and clearly stated paper on 'The Origin of Species through Isolation,'[1] has suggested the following as a general law:

> Given any species in any region, the nearest related species is not likely to be found in the same region nor in a remote region, but in a neighboring district separated from the first by a barrier of some sort.

This we were inclined to accept as applicable to plants with little or no hesitation.

For several years the writer has studied, more or less critically, the plants of a well-defined floral region, and it has almost invariably been his experience that the difficult problems which confronted him were not the discrimination of the various species of a given locality or region, but the question of the relationship of his plants to similar forms occurring in another, usually adjoining, territory.

Consequently it was with considerable surprise that we read Professor Lloyd's[2] bold assertion that, if the general law stated by President Jordan were put in the converse form, 'it would be more in harmony with the facts in the case as understood by the botanists.'

In addition to the general and 'sweeping'

[1] SCIENCE, II., **22**: 545–562. November 3, 1905.
[2] SCIENCE, II., **22**: 710–712. December 1, 1905.

statements Professor Lloyd has offered a few specific illustrations, as well, to uphold his point, and, if we infer correctly, these are chosen from a great number of cases which he considers applicable. We naturally assume, therefore, that they are examples which he thought most conclusive. How well these really substantiate his assertions, however, can only be ascertained by carefully considering the merits of each illustration. And in doing this two predominant questions must be kept clearly in mind: (1) Are we dealing with the *most closely* related species? (2) Are the two species growing associated under the same conditions?

Viewed from this standpoint some of Professor Lloyd's illustrations not only do not agree with his assumption, but offer excellent examples of the general law suggested by President Jordan. For instance, *Viola lanceolata* and *V. primulæfolia*, we are led to infer, are associated with each other in the same habitat, a fact upon which at least one well-known authority is very skeptical. But, granting that they do so occur, are they more closely related to each other than to some other species? Three students of the genus whom I have consulted are unanimous in the opinion that they are not. On the contrary, *V. lanceolata* has its closest relative in *V. vittata* of the gulf states, while *V. denticulosa*, also of the southern region, holds a similar relation to *V. primulæfolia*. Both *V. lanceolata* and *V. primulæfolia*, therefore, have their closest relatives not associated with them, but growing in adjoining regions, separated by one of nature's well-marked barriers, that of temperature.

Again, *Rhodiola integrifolia*, it is claimed, occurs associated with *R. polygama* in Colorado, a statement which, it is true, we are unable to refute; but one of the recognized authorities of this genus does not hesitate to assert that *R. alaskana* and not *R. polygama* is the species nearest *R. integrifolia*. Both of these occur in Alaska, but there, too, is the barrier intervening; for while *R. integrifolia* is an alpine plant, *R. alaskana* is confined to the coastal region.

Fern students will not agree that *Dryopteris marginalis* and *D. goldiana* are the two more closely related species in that group. On the contrary, *D. goldiana* is usually considered most closely related to that far northern and western plant known as *D. filix-mas*.

If the opportunity were afforded and if we were able to gather the necessary data doubtless nearly all of Professor Lloyd's examples would be found fully as misleading. Enough have been refuted, however, to clearly show that we are not to accept his statements as at all conclusive.

Furthermore, our fellow botanist states, as his opinion, that it is easier to find exceptions to President Jordan's rule than facts in support of it. With this assertion we believe it absolutely impossible for any botanist to agree who is at all familiar with plants in the field, or who has ever given the question of geographical distribution any serious consideration. The writer most assuredly does not find that difficulty. Many cases among the plants with which he is most familiar in the field are brought to mind; some of which he will take the liberty of presenting for the careful consideration of those interested in this general discussion.

It may be well to state in the beginning that the examples chosen are limited mainly to the flora of the California province, partially because the writer is more familiar with the plants of that region, but also because the barriers are more clearly defined there and can be more readily appreciated.

Among the conifers of the Pacific coast are several suggestive illustrations of the isolation theory. For instance, we find *Pinus contorta* along the northern seacoast, while on the mountains is its very near relative *P. murrayana*. Again, *Pinus ponderosa* of the Pacific slope is represented in the Rocky Mountains by *P. scopulorum*. *Pseudotsuga mucronata* is replaced in southern California by *P. macrocarpa*, while *Cupressus macrocarpa* of Monterey Bay and *C. goveniana* of the northern coast ranges of California are two closely related species.

Castanopsis chrysophylla of the coast ranges has its nearest relative in *C. sempervirens* of the Sierra Nevada. The same may be said

of *Garrya rigida* and *G. fremontii,* and a host of others.

The genus *Rhamnus,* as represented on the Pacific slope, offers some excellent illustrations. *Rhamnus californica* of the coast ranges of central California has at least two very near relatives occurring in adjoining regions. *R. purshiana* of the northwest region and *R. tomentella* of the foothills of the Sierra Nevada and southern California. And, as we would naturally suspect, from the theory of isolation, the species occurring in central California is the intermediate one.

Ceanothus integerrimus (*C. andersoni*) of the Santa Cruz Mountains, *C. nevadensis* of the Sierra Nevada and *C. puberulus* of the San Bernardino Mountains are three very closely related species occurring in three different mountain ranges of the California province.

Adenostegia rigida of the coast ranges of central California, *A. filifolia* of southern California, and the Sierra Nevada form, not yet clearly defined, but bearing the name *A. rigida brevibracteata,* are, also, three very closely related species, clearly marked in the more isolated portions of their ranges, but apparently intergrading where the three ranges converge.

In southern California may be found other illustrations fully as conclusive. The flora of this region is naturally very similar to the more typical Californian flora, but it also has certain affinities with that of the Arizona region. Here occurs *Quercus engelmanni,* and it is in the Arizona region that we find its closest relative, *Q. oblongifolia.* Again, *Euphorbia palmeri* is represented in Arizona by *E. palmeri peplifolia* and *Ceanothus palmeri* by *C. myrianthus.*

The coastal and desert regions of southern California also present some well-marked examples. In this connection we need only suggest *Eriogonum fasciculatum* and *E. polifolium, Stenotus linearifolius* and *S. interior, Bebbia juncea* and *B. aspera.*

On the mesas about San Diego is the very common shrub, *Adenostoma fasciculatum obtusifolium,* which is wholly replaced northward by the typical form. Again *Calochortus weedii,* also limited to the same general region, is replaced by *C. weedii purpurascens* in the vicinity of Los Angeles and Santa Barbara.

In the above illustrations it will be noted that the species selected are very closely related. Some may be inclined to criticize this and it may be argued that the plants mentioned are, at least in some cases, not distinct species. This we are perfectly willing to admit as plausible. They may be only subspecies; but they are, nevertheless, just as suggestive of the isolation theory.

We do not wish it understood, however, that we consider isolation the direct cause of the origin of species; but, whatever the cause, we do maintain that the evidence in favor of isolation as an important factor in the *perpetuation* of closely related species is almost overwhelming in plants as well as in animals. And any theory of evolution which will not allow for this fact can not possibly prevail.

LeRoy Abrams.
United States National Museum.

GROUND ROCK FOR FERTILIZING PURPOSES.

To the Editor of Science: For several years the Division of Tests which is now attached to the Office of Public Roads has been investigating, in connection with the study of macadam road materials, the cause of the binding power of rock dust. These investigations have led to the conclusion that the decompositions that take place in rock powders under the action of water, when in a very fine state of subdivision (180-mesh and finer), and especially when the grinding has been done wet, bear upon a great many practical problems, some of which are of the very highest importance.

It appeared in fact that many of the feldspathic rocks which are more or less rich in potash might be made directly available as a fertilizing material. Although somewhat out of the line of experimentation of this office, under proper authorization the writer conducted a series of experiments on tobacco seedlings which showed that fine-ground orthoclase was very nearly, if not quite, as efficient as a source of potash plant food as the more

soluble potash salts which are in ordinary use. After these experiments were concluded the attention of the writer was called by Dr. F. K. Cameron to the fact that the value of ground orthoclase as a fertilizer had been pointed out by several investigators in the past, notably by Magnus in Germany (1850), Aitken in Scotland (1887) and by the Maine State Experiment Station and the Colorado Experiment Station (1889 and 1901) in our own country.

A paper is being prepared to be published in due time which will present all the information so far obtained upon this subject. This country is at present dependent upon foreign sources of supply for all the potash used annually for fertilizer by our farmers and growers, and in case of foreign wars, embargoes or reprisals, we should be cut off from a steady source of supply. The great stimulus that has been given by our growing cement industry to the art and economics of the milling of rocks to almost flour-fineness makes it possible to-day to consider the feasibility of grinding, not only some of our feldspar deposits, but even our richer potash-bearing feldspathic rocks, like some of the granites which we possess in unlimited quantities. To the proper solution of a problem of this kind it is necessary to enlist the interest and attention of men familiar with the economics of rock grinding and the handling and transportation of material in bulk, as well as of growers and experimental agriculturists. The object of this communication is to call attention to the interest and importance of the problem, and to open the field to all who are desirous of experimenting or of making actual use of ground rock for fertilizing purposes.

ALLERTON S. CUSHMAN.
OFFICE OF PUBLIC ROADS.

SPECIAL ARTICLES.

ZIEGLER'S THEORY OF SEX DETERMINATION, AND AN ALTERNATIVE POINT OF VIEW.

IN his recent pamphlet entitled 'Die Vererbungslehre in der Biologie' Professor H. E. Ziegler proposes a new theory of sex determination. It was said even at the time of Drelincourt that no less than 262 groundless theories of sex had been suggested; and it may be added that since that time there has been no falling off of interest in the sex question if the number of new theories proposed is a criterion.

Ziegler attempts to bring the question of sex determination under the prevailing view of specific chromosomal action. In recent years cytological speculation has largely rested on the assumption that the chromosomes are the sole bearers of the hereditary qualities. Hence all questions of inheritance have been referred to them, and in consequence their changes in the cell have attracted extraordinary attention. Many theories of heredity have been based on the shifting changes in the chromosomes alone. Their capacity for stains has greatly facilitated their study, while the rest of the cell that does not show much differentiation in staining capacity has been often ignored. Only in the case of the egg has the cytoplasm received anything like adequate treatment. The experimental work of Driesch, and of Wilson, in particular, has shown the important rôle that the cytoplasm plays in development.

Ziegler's primary assumption is that the chromosomes that arise from a female individual have a greater tendency to produce a female; and those that originate from a male individual have a greater tendency to produce a male. Since the child gets as many chromosomes from the father as from the mother, the parental chromosomes as such can not determine the sex. But it is to be recalled that amongst the parental chromosomes some have come from the grandfather and some from the grandmother. The relative number of chromosomes from the maternal and paternal lines will be variable in number on the current assumption that at the reduction division it is merely a question of chance which member of a pair of homologous chromosomes goes to one pole of the spindle, and which to the other. If the chromosomes of the grandfather predominate in the offspring it will be a male; if the grandmother chromosomes predominate a female develops.

To take an example. If the somatic num-

ber of chromosomes for the human species be assumed to be 24; the child gets 12 from the father and 12 from the mother. If amongst the former there are 8 grandmother chromosomes and amongst the latter 7 grandmother chromosomes the child will be a girl, for there are at least 15 of the 24 derived from the grandmothers' side.

Ziegler admits that his grandmother theory of sex will not apply to all cases. The 'peculiar' methods of reproduction of the honey bee, the gall wasps, the daphnias, rotifers, and *Dinophilus* can not, he says, be explained in this way. This admission is in itself a serious objection to the theory, for any satisfactory theory of sex must be prepared to account for this class of cases, that can not be put aside by calling them 'peculiar.' But there are other and more serious objections to be urged against Ziegler's view.

In the first place, Ziegler's theory is only a special application of the *differential* chromosome theory, which Sutton first suggested might account for the Mendelian ratio. Boveri has recently followed Sutton's interpretation, and Ziegler also, it appears now, adopts this point of view. Let us look for a moment more closely at this hypothesis, since it has an important bearing on Ziegler's assumption in regard to sex. Two views, both purely hypothetical, may be held as to the way in which the chromosomes represent the heredity qualities. Either, each chromosome contains only one set of characters, *i. e.*, the chromosomes are all different in regard to their hereditary material, or, they are all alike in this respect. Mendel's law is sometimes worked out on the former supposition, and appears to give a satisfactory explanation of how the *assumed* purity of the germ cells of hybrids may arise. On the other supposition, viz., that the chromosomes are all alike, it is difficult to explain the supposed purity of the germ cells of hybrids. In fact, on this supposition it can rarely happen that the germ-cells are pure in respect to any one character. If we reject the assumed purity of the germ-cells in Mendelian cases, and still attempt to explain the Mendelian ratio on our second assumption, viz., that the maternal or the paternal chromosomes are all alike, we can give a formal solution for some cases provided we assume that the reduced number of chromosomes is an unequal one; for, the results may then depend on whether more of the grandfather chromosomes or more of the grandmother chromosomes happen to get into a particular cell. But if we examine the list of cases given by Ziegler himself we find that the reduced number of the chromosomes is an even one in 29 species, and odd only in 10.

On Ziegler's theory of sex it is evident that whenever the reduced number of chromosomes is even there must often occur an exact balance of grandmother and grandfather chromosomes, hence the child can have no sex at all! For a small number of chromosomes this would often occur.

There is also a serious difficulty in the case of the other assumption that chromosomes are individually different. The peculiar inheritance of the Mendelian extracted recessives is difficult to understand from this point of view. For example, if a white mouse is bred to a gray mouse gray offspring will be obtained. If these gray offspring are inbred they give some gray and some white according to the Mendelian ratio. These white mice (extracted) are assumed to have been formed by pure white-bearing germ cells meeting white-bearing germ cells, but that this explanation will not account for their origin is shown by crossing these extracted white mice with black mice. The offspring will be gray according to Cuénot. This must mean that the extracted whites must contain gray in a latent condition, and moreover in sufficient amount to dominate the black color of the black mouse. Cuénot who has discovered this and similar facts offers an hypothesis to account for them, but it is an hypothesis far removed from the chromosome theory as applied to Mendelian cases, at least in the form maintained by Ziegler. Since neither assumption in regard to the chromosomes is capable of explaining certain results of the Mendelian cases the most obvious conclusion is that the germ cells are not 'pure,' and that the Mendelian ratio is not due to this sort of purity but to dominance and recessiveness of contrasted charac-

ters that depend on some other relation in the germ cells than that brought about by the shifting of the chromosomes in the reduction division to produce 'pure' gametes.

Ziegler's failure to give a satisfactory account of sex determination on the *differential* chromosome basis raises the wider question as to whether at the present time we are really obliged to look in this direction for a solution of the question. The known facts in regard to sex indicate that we have to deal with two sharply contrasted, yet interchangeable states. Furthermore, the facts seem to indicate that some internal mechanism exists that gives with great precision the one or the other condition. We lack completely at present the necessary knowledge of the chemistry of the cell on which alone we can hope to establish a real theory of sex determination. It might be possible indeed to invent a purely fictitious, *quasi* chemical, hypothesis, such, for instance, as assuming that the female and the male represent two contrasted conditions of the same protoplasm, one state being a combined (the female) and the other a separated (male) condition of the aggregate bodies (molecules) of which the protoplasm is composed. While we might, were it worth while, work out this or some similar idea into a more or less consistent hypothesis, the only value that such a conception might have at present would be to indicate that sex determination may not be the result of differential *nuclear* divisions that locate sex determining chromosomes in different cells, but that the process is chemical rather than morphological.

T. H. MORGAN.

COLUMBIA UNIVERSITY.

THE SARGASSO FISH NOT A NEST-MAKER.

EVER since 1872 the sargasso fish (*Pterophryne histrio*) has been famous as the builder of a remarkable globular nest made of the sargasso weed, in the midst of which it finds a congenial home. Professor Louis Agassiz first described such nests observed by him in December, 1871, during a voyage to Brazil and attributed them to the Antennariid. No one has since doubted the accuracy of the identification, and in innumerable works it has been accepted as well established. A few weeks ago, however, Dr. Hugh Smith, deputy fish commissioner, informed me that he had obtained eggs laid by the sargasso fish and, on a visit to his office, he showed me some under a microscope, and I was surprised to find that they were quite different from those found in connection with the nests and which had been elaborately described by Vaillant and Möbius. Later I received a letter from Professor E. W. Gudger, of the State Normal College of North Carolina, containing an account of the pterophryne's oviposition. This corresponds remarkably with that practised by the fish's distant relative, the angler (*Lophius piscatorius*). The elaborate provision thus made specially for the eggs, as well as the absence of polar filaments, negatives the attribution of such eggs to the nest-maker of the sargasso sea and leaves the question of the real maker an unsolved problem. Similar eggs were found free on the surface of the sea off the African coast and noticed by Cunningham (1887) but not identified. Can such be the product of a flying-fish?

The fish, whatever it may be, is probably not a direct maker of the nest but the filaments of the eggs may, perhaps, become mechanically entangled with the fronds as well as with each other and the contraction into a subglobular mass may be the result.

Professor Gudger's communication is herewith submitted.

THEO. GILL.

A NOTE ON THE EGGS AND EGG-LAYING OF PTEROPHRYNE HISTRIO, THE GULFWEED FISH.

SPECIMENS of the gulfweed fish occasionally drift with the *Sargassum* into the harbor of Beaufort, N. C., and are picked up along the beach by boys and brought to the laboratory of the United States Bureau of Fisheries.

When I reached the laboratory about the middle of June, 1903, there were two of these interesting fishes confined in an aquarium of running salt water. These were put in my care and on one of them and its eggs the following observations were made. The two fishes were of unequal size and were contin-

ually fighting. In these daily combats, the smaller suffered considerably, its filamentous appendages and even the ends of its fins being bitten off. Finally it was killed and preserved as a museum specimen. Its sex was not determined.

The larger fish, thus left alone, did not seem to miss its companion. It fed voraciously, eating pieces of oyster, bits of shrimp and small fishes alive or dead. In catching its prey it would with closed mouth draw near, and then opening it suddenly (the premaxillaries and lower jaw protruding considerably), would take in its prey with an instantaneous gulp. Frequently, however, *Pterophryne* would remain perfectly quiet amid the *Sargassum*, holding on to the branches with its hand-like pectorals and waiting for the little fishes to come near it. It grew very fat with high feeding and its abdomen became much enlarged, in front of the anus becoming as square as if it had been cut to shape with a knife. Nothing, however, was thought of this save that the fish was getting very fat.

About noon, on July 25 (after the fish had been in captivity seven weeks), the writer passed through that part of the laboratory where the aquaria were, and found that the Sargassum-fish had laid a large quantity of eggs which, imbedded in jelly, floated at the surface of the water. The eggs, whose number there were no means of computing, together with the enveloping jelly, formed a long string which would have more than filled a pint cup (250 c.c.). This jelly had evidently swollen on contact with the water, for the fish, which was only three or three and one half inches long, had only about one third of the volume of the eggs and jelly combined. After the extrusion of the eggs, the size of the fish was noticeably decreased, and the 'fatness' largely disappeared.

The eggs were examined alive and, later, sections were made of them. The germinal disk begins to form shortly after the eggs are laid and this fact is noteworthy, in that, according to Agassiz and Whitman, in pelagic fish eggs this is generally not formed until after fertilization. The formation of the germinal disk, however, proceeds unequally rapidly, and, at the end of four and one half hours (at which time the eggs now in my possession were killed), had in no egg examined made such a round, clearly marked off, button-shaped disk as all workers have found in the egg of the salmonoids, and as I have figured for the pipefish, *Siphostoma floridæ*. On the contrary, observations on the living egg, confirmed by the study of sections, show that the germinal disk is partly sunken in a depression in the yolk, half of its thickness being below the general level of the yolk. The germinal disk in the eggs of the Salmonidæ is sunken in a depression, in the center of which it forms a mound, touching the yolk only at its base. In *Pterophryne*, however, the protoplasm entirely fills the depression in the yolk (this in eggs four and one half hours old), a phenomenon, so far as I know, not before reported for any teleostean egg.

The protoplasm first exists as a shell of uniform thickness surrounding the yolk, and in the living egg, shortly after it begins to thicken at one pole to form the germinal disk, there may be seen in optical section a clearly defined nucleus. On the contrary, however, I have never been able, either in sections or in the living egg of the pipefish, to find a nucleus in the one-celled stage. Unlike most pelagic eggs, there are no oil drops visible in the *living* egg of *Pterophryne*. In sections, some eggs show a small number of minute vacuoles indiscriminately scattered under the germ disk and around the circumference of the yolk; some are devoid of these, and two eggs had two large ones each. These vacuoles were in life presumably filled with oil drops, which have been dissolved out by the alcohol. In the living eggs, no oil drops were ever seen and until the sections had been examined the writer was confident none existed. Indeed, they would seem to be a negligible quantity. The function of the jelly then evidently is to serve as a float to keep the eggs at the surface of the water.

The yolk is colorless and without texture, and, being perfectly homogeneous, is so translucent as to approach transparency. The egg, which is surrounded by a thin, smooth, transparent shell, is as easily separated from

the jelly as that of the frog. The eggs vary in size, but on the average are about 1 mm. in diameter.

The fish continued to thrive, although feeding perhaps less ravenously, and was in perfect condition some five weeks later when I left the laboratory. About half the eggs were preserved in formalin, and, excepting the few kept by the writer, were deposited in the museum of the laboratory at Beaufort.

These observations were made at the laboratory of the United States Bureau of Fisheries of Beaufort, N. C. For permission to make use of the excellent facilities there, I am indebted to the Commissioner, Hon. George M. Bowers.

E. W. GUDGER.

STATE NORMAL COLLEGE,
GREENSBORO, N. C.,
October 7, 1905.

SEX DIFFERENCES IN THE ESTIMATION OF TIME.

IN volume 19, pages 707–708, of this journal Professor Robert MacDougall published an account of some experiments on the 'time sense' of men and women which seemed to indicate certain important sex differences. As he states, however, 'the noting of these sex differences was incidental to the primary purpose of the test, and attention is called to them here in order that observations on the part of others may be brought into comparison with the results presented by this group of persons.'

Since MacDougall's results were obtained by the examination of only fifteen persons of each sex, further investigation of the subject is evidently important. We have, therefore, carried out experiments along similar lines with hundreds of subjects for the purpose of ascertaining the significance of sex, age and physiological rhythms in the estimation of time. In the present report we shall consider only the relation of sex to time judgments.[1]

The subjects were required to judge the length of each of four intervals, 18, 36, 72 and 108 seconds, under four different conditions, which are designated in the table as idleness, estimating, reading and writing. During the *idleness* intervals the subject waited passively for the elapsing of the time; during *estimating* he made use of the method of his own selection by which he could best judge of the length of the period; during *reading* he listened while the experimenter read, and during *writing* he wrote from the dictation of the experimenter.

For comparison of the sexes groups of 251 males, from seventeen to twenty-three years old, and 274 females, from seventeen to twenty years old, were examined. In the accompanying table we present the means, mean variabilities and relative variabilities of each sex group for each interval and filling.

Intervals.	Fillings.	Mean.		Mean Variability.		Relative Variability.	
		M.	F.	M.	F.	M.	F.
18″	I	17.7″	20.7″	5.4″	10.4″	30	50
	E	19.5	25.6	4.9	9.8	25	39
	R	15.5	18.5	4.9	9.1	31	49
	W	11.5	15.6	3.7	8.6	33	55
36″	I	33.3	42.8	9.1	16.6	27	38
	E	33.1	41.5	8.4	15.2	25	37
	R	32.1	41.7	8.4	16.4	26	39
	W	24.7	30.1	9.0	14.7	36	49
72″	I	63.3	73.0	17.2	27.2	27	37
	E	63.1	77.1	16.0	26.6	27	34
	R	57.9	70.8	17.3	30.3	30	43
	W	51.2	54.9	19.8	24.2	37	44
108″	I	92.7	113.4	29.8	40.1	32	35
	E	99.8	114.9	26.3	36.4	26	32
	R	90.1	100.5	28.3	40.2	31	40
	W	75.5	87.5	32.4	45.3	42	52

Summarily stated our investigation indicates the following sex differences:

1. The females were much less accurate than males in the estimation of the intervals under consideration. The range of the male judgments was from 1 to 300 seconds, that of the female from 1 to 400 seconds.

2. The females greatly overestimate the intervals in most cases, whereas the males almost invariably underestimate them. The length of the second itself is usually much shorter in the judgment of the female than in that of the male.

[1] A detailed account of the investigation is in process of publication in volume 2 of the *Harvard Psychological Studies*.

Our results agree entirely with those of MacDougall. Discussion of their significance may well be postponed until the completion of an investigation, now in progress, of the relations of age and physiological rhythms to time estimation.

ROBERT M. YERKES,
F. M. URBAN.

HARVARD UNIVERSITY.

PRELIMINARY ANNOUNCEMENT CONCERNING A NEW MERCURY MINERAL FROM TERLINGUA, TEXAS.

THE mercury minerals of the Terlingua district, Texas, are noted for the unusual composition of several of their number. Besides cinnabar, calomel and mercuric oxide, two oxychlorides, eglestonite and terlinguaite, have been described in detail by Professor A. J. Moses (A. J. S. **166**, 253, 1903), and a third, as yet unnamed, has been provisionally identified by him as likewise an oxychloride. This last, the No. 5 of Professor Moses, seems to be the chief mineral in a number of specimens from the Terlingua District lately received for identification from Mr. H. W. Turner. Its examination reveals a composition most singular and apparently representative of a class of compounds hitherto unknown in nature, viz.: mercur-ammonium salts. So far as yet known, the qualitative composition is represented by the components Hg, N, Cl, SO_4, probably O and possibly H. The tests, both qualitative and quantitative, thus far made, seem to show with little room for doubt that the mercury and nitrogen form the mercur-ammonium radical. Dr. P. G. Nutting, of the Bureau of Standards, has kindly examined spectroscopically the products of progressive heating of the mineral under reduced pressure; and besides nitrogen, mercury, chlorine and sulphur, obtained a small amount of helium. Singularly enough, this last seemed to come off wholly during the first warming of the mineral and before it underwent any visible breaking-up.

The complete examination of this novel mineral and its associated mercury compounds will probably consume much time. In order to reserve the field for the chemical examination by myself and the crystallographical (now in progress) by Mr. W. T. Schaller, this preliminary announcement is made.

W. F. HILLEBRAND.

U. S. GEOLOGICAL SURVEY,
WASHINGTON, D. C.,
December 14, 1905.

QUOTATIONS.

UNIVERSITY ADMINISTRATION.

IN the December *Popular Science Monthly* Professor John J. Stevenson again takes up the question of the status of American college professors, maintaining that the present tendency to subordinate them to the trustees and to the president is contrary to the real interests of educational progress. The trustees are successful men of business or professional life for the most part, with neither the time nor the expert knowledge necessary to administer wisely the internal affairs of an institution of learning. The president, once a good professor as well, must now be a successful business manager and money-getter, teaching little if at all, and, like the trustees, possessing neither the time nor the knowledge requisite to the sagacious exercise of the powers which are generally either sought by him or thrust into his hands under existing conditions. The trustees, then, should confine themselves strictly to the management of the property and the task of securing funds for the carrying out of such educational policies as the teaching force may advise. Even in filling vacancies in their own number, their action, he is inclined to think, should be subject to veto by two thirds of the full professors. Vacancies in the faculty should be filled by the faculty itself, subject to confirmation of the trustees merely *pro forma*, or to rejection in case there are not funds available for the required salary. The presidency should be abolished altogether, each faculty selecting its own executive head, who should be simply *primus inter pares*, and the mouthpiece of the faculty in its relations with the trustees. It is noticeable that the editor of the *Monthly*, in a paragraph relating to the recent conference of college and university trustees held at the installation of the presi-

dent of the University of Illinois, questions the theory that the recent rapid growth in the material endowment of colleges is the work of the presidency, and also suggests that, even if it were, institutions are not always such centers of education, scholarship and research as their liberal endowments would lead one to suppose. It is only the great teacher and investigator, after all, who can impart anything but mere material greatness to an institution of learning.—*The Nation.*

A COLLEGE was originally a society of scholars organized for the pursuit and acquirement of knowledge. It sent forth its alumni to be ministers, jurists, physicians, teachers—leaders in their communities. It was for this purpose that colleges were founded in our country. They stood for the highest ideals of manhood. They and their graduates created and represented those ideals for which the college was responsible.

The president was then the head of the college. To the community he stood for what the college was and was doing for it. The people saw in him the disciplined mind and the all-around manhood which they honored and to which they taught their sons to aspire. To the faculty he was the leader in their plans, and the inspirer of their aims. Students went to the college already reverencing him as the embodiment of a high ideal, went to him when there as counsellor and friend, passed under his instruction in the upper classes and carried the impress of his character through their lives. Such men as Mark Hopkins, of Williams, and Theodore Woolsey, of Yale, and James Fairchild, of Oberlin, reproduced their noblest qualities directly and indirectly in thousands of leaders of men, and no men in any office in this country have surpassed them in its service.

The average college president of to-day represents no such ideal. He is not sought for it, has no opportunity to realize it. There are men of the type here described, but they are exceptions. The college president is chosen because of his ability as a money getter. His business is to beg from rich men and from women who have fortunes left to them. His success is measured by the number and cost of the buildings erected with the money he has raised and by the amount of endowment he has secured. There are college presidents whose faces are more familiar to business men in Boston and New York than to their own students, who have earned no more right to a place in the ranks of scholars than the captains of their college football teams, and who are less honored and heroic than they are in the public's esteem.

None feels the degradation of the high office of the college president as keenly as he does. In many cases he has accepted his office with a worthier purpose than that which he has been forced to adopt. He has yielded most reluctantly to the compulsion to join the already overfull procession of those who were nominally chosen as intellectual and moral leaders of men, who crowd on one another in the anterooms of business offices and in ringing the doorbells of the rich.—*The Congregationalist.*

A NEW SCHOOL FOR CLAY WORKERS.

THE University of Illinois has issued a bulletin describing the courses in ceramics which it now offers for the first time. The rapid destruction of our forests and the consequent increase in value of all kinds of lumber are causing people to look with new interest toward clay products as the most promising building and decorative materials of the near future, and this interest has caused a demand for cheaper and better materials of this class.

Clay workers are beginning to realize that in order to meet this demand they must put men who are well educated along lines of applied science and mechanics in control of their plants and are inquiring where such men can be found. As there are but three schools in this country which offer instruction especially planned to meet the needs of clay workers, the demand far exceeds the supply and manufacturers are willing to pay well for the services of competent men, hence the University of Illinois feels justified in adding such instruction to the technical courses which it has offered heretofore.

Two courses are offered, both of which

recognize the fact that no good work can be done in ceramics which is not based on the three sciences, chemistry, physics and geology. With these sciences and technical instruction in clay working as its backbone, the course in ceramics also offers instruction in art, English and modern languages, mathematics, physical training and military tactics.

In the course in ceramic engineering, instruction in art and in certain technical subjects is replaced by elementary courses in electrical, mechanical and civil engineering. The course is intended principally for those who wish to install plants rather than operate them. Substitutions are also suggested which will adapt the course to the needs of the manufacturer of limes and cements.

Students in all except the strictly technical subjects work in the laboratories of the scientific and engineering departments. The special ceramic laboratories are equipped with kilns, furnaces, presses, mills, jiggers, whirlers, and such other machines, all of the latest and most approved types, as are necessary to enable the student to do thoroughly practical work.

The school counts among its friends the managers of nearly all the large clay-working establishments in Illinois, and there seems to be no reason why it shall not speedily become very helpful to the clay interests of the state and nation and at the same time open to young men a new and profitable field for effort.

PHYSIOLOGY AND EXPERIMENTAL MEDICINE AT THE NEW ORLEANS MEETING.

THE sessions of Section K of the American Association for the Advancement of Science, which will be held on the morning and afternoon of January 1, promise to be of unusual interest. The morning session will be opened by an address by the vice-president, Dr. William T. Sedgwick, on 'The Experimental Method in Sanitary Science and Sanitary Practise.' The remainder of the morning session and all of the afternoon will be devoted to a symposium on yellow fever and other insect-borne diseases. Yellow fever in its various phases will be discussed by Drs. J. H. White, Quitman Kohnke, James Carroll and H. A. Veazie. It is expected that Dr. Edmund Souchon, Surgeon-General Wyman and Col. W. C. Gorgas and other specialists, will also take part in the discussion. Dr. William S. Thayer will read a paper on 'The Problem of Prophylaxis Against Malaria in the United States,' Dr. Henry B. Ward will consider filariasis and trypanosome diseases, Dr. Charles W. Stiles will present a résumé of facts bearing on the principles involved in the transmission of diseases by insects, and Dr. Gary N. Calkins will discuss the protozoon life cycle. Dr. L. O. Howard will talk on mosquitoes that carry disease and Mr. Henry Clay Weeks, secretary of the American Mosquito Extermination Society, will present the practical side of mosquito extermination.

WILLIAM J. GIES,
Secretary.

SCIENTIFIC NOTES AND NEWS.

DR. HENRY S. PRITCHETT has resigned the presidency of the Massachusetts Institute of Technology to accept the presidency of the Carnegie Foundation for pensioning college and university professors, the offices of which will be in New York City.

A DEPARTMENT of botanical research to include the Desert Laboratory and other botanical projects, was established by the action of the trustees of the Carnegie Institution at a recent meeting. Dr. D. T. MacDougal has resigned as assistant director of the New York Botanical Garden to accept the post of director of the newly organized department.

MAJOR D. PRAIN, hitherto director of the Botanical Garden at Calcutta, has been appointed to the directorship of Kew Gardens, vacant by the retirement of Sir William Thiselton-Dyer.

MR. F. W. DYSON, F.R.S., chief assistant at Greenwich Observatory, has been appointed astronomer royal for Scotland, and professor of practical astronomy in Edinburgh University, in the room of the late Professor Copeland.

PROFESSOR WILLIAM STIRLING, M.D., Brackenbury professor of physiology and histology

in the Victoria University, Manchester, has been elected Fullerian professor of physiology to the Royal Institution, London.

DR. WILLIAM OSLER, regius professor of medicine at Oxford, is a passenger on the *Caronia,* which is due in New York at the end of this week.

The Botanical Gazette states that Professors Macbride and Shimek, of the University of Iowa, spent part of last summer in the southwestern deserts, especially in the Salton basin. The university herbarium now contains a fairly complete representation of the flora of New Mexico and Arizona.

DR. W. WIRTINGER, professor of mathematics at Vienna, has been elected a member of the Vienna Academy of Sciences.

THE Royal Society of Arts has awarded a silver medal to the Hon. Robert P. Porter, former head of the U. S. Census Office, for his paper read before the society, on 'London Electric Railways.'

The British Medical Journal states that Professor Czerny has resigned the chair of surgery in the University of Heidelberg, which he has held since 1877, in order to devote himself entirely to the duties of director of the Institute of Cancer Research. He will be succeeded in the chair of surgery by Professor Garré, who accepted a call to Breslau after the death of Professor von Mikulicz.

DR. A. B. MEYER has been dismissed from the directorship of the Zoological and Ethnographical Museum at Dresden for alleged irregularities in the conduct of the museum.

ON December 29 Dr. Thomas Darlington, health commissioner of New York, will deliver a public lecture at the Academy of Medicine on the results of the work of the two commissions appointed last spring to study pneumonia and cerebrospinal meningitis.

THE committee appointed to carry the proposal of a memorial to Rudolf Virchow into effect has now a sum of $20,000 at its disposal. Of this amount $9,000 has been contributed by subscribers and $11,000 by the city of Berlin. Three prizes, of the value respectively of $750, $500 and $250, are offered for the best design of a memorial. Drawings must be sent in before April, 1906.

DR. WALTER WISLICENUS, associate professor of astronomy at Strassburg, died on October 3, at the age of forty-six years.

THE death is announced of Professor von Leuthold, surgeon-general of the German army.

DR. ERNST ZIEGLER, professor of pathology in the University of Freiburg, died on November 30, in his fifty-seventh year.

IN connection with the approaching meeting of the American Association the New England Passenger Association offers a rate of a fare and a third to Washington or other trunk line southern or western termini, added to one fare plus twenty-five cents for the round trip (this does not include the Eastern Steamship Company).

THE fourth annual meeting of the American Paleontological Society (Vertebrates) will be held at the American Museum of Natural History, New York, on Wednesday and Thursday, December 27 and 28. This is the second regular meeting, and will be presided over by Professor William B. Scott of Princeton University, Dr. Marcus S. Farr, of the same institution, acting as secretary. Professor Scott's presidential address will be upon the geology and paleontology of South Africa, so far as observed during his recent visit in connection with the British Association for the Advancement of Science.

A MEETING of those members of the Division of Hydrology of the United States Geological Survey who are engaged in artesian water and related geologic investigations was held in Washington on December 9, for the purpose of organizing a society for the discussion of problems relating to underground waters and methods of increasing the efficiency and economic value of investigations. Among those attending the meeting were F. H. Newell, chief engineer of the Geological Survey, and officials and members of the division of hydrology. The formation of the new society was decided upon, but the details of organzation were left to a future meeting.

THE anniversary meeting of the Royal Society was held on November 30, with Sir William Huggins in the chair. After the report of the council had been presented and the president had delivered an address, Lord Rayleigh was elected president of the society, and presided at the dinner in the evening. In answer to the toast of 'The Medallists,' Professor Mendelièff, Professor Righi, Professor Poynting and Professor Sherrington replied.

THE International Congress of Prehistoric Anthropology and Archeology will hold its thirteenth meeting at Monaco, under the patronage of Prince Albert the First, from April 16 to 21, 1906. Detailed information as to the congress may be obtained on application to the general secretary, Dr. Verneau, 61, Rue de Buffon, Paris.

THE new building of the Rockefeller Institute at the foot of East 56th St., New York City, will be ready for occupancy in January.

Nature, quoting from the *Chemiker-Zeitung,* states that the German state grant for the support of scientific, technical and similar undertakings is to be increased by 115,000 Marks. The sum of 179,500 Marks is to be spent upon increasing the accommodation for the permanent exhibition devoted to the interests of the working classes; 120,000 Marks to be a first instalment for investigation of sleeping sickness; 30,000 Marks to be devoted to the development of the Starkstrom laboratory of the Reichsanstalt; 43,850 Marks to be contributed to the kite station on Lake Constance for experimental investigations of the higher air strata.

WE learn from *The British Medical Journal* that Professor Debove recently presented to the Académie de Médecine, Paris, the report for 1904 of the Scientific Information Bureau. During the year 8,000 persons applied for information as to courses of instruction, laboratories, hospitals, libraries and archives. Fifty-five per cent. of the applicants were foreigners, the countries represented being Great Britain, the United States, Russia, Scandinavia, Italy, Spain, South America, Germany, Japan and China. Sometimes there were from seventy to eighty applicants in one day. The staff of the bureau consists of four persons, and answers to questions can be given in five languages. The members of the bureau are paid by the Municipal Council and the Council of the University. It may be mentioned that the information supplied is by no means confined to matters relating to medicine; replies are given to inquiries as to the French language and literature, the fine arts, industrial physics and chemistry, etc.

UNIVERSITY AND EDUCATIONAL NEWS.

MRS. HELEN C. COBURN has by her will made public bequests mounting to $450,000. $10,000 are given to Radcliffe College, $40,000 to Phillips-Andover Academy, $75,000 to the Massachusetts General Hospital, and considerable sums to institutions for the education of negroes.

MR. ANDREW CARNEGIE has agreed to give $100,000 to equip the electrical engineering laboratory of Union College, provided the college raises $100,000 to endow it.

YALE UNIVERSITY has received from two anonymous donors a gift of $75,000, which, subject to certain annuities, will be used to found a lectureship on 'The interrelation of religion, science and philosophy.'

OBERLIN COLLEGE receives $10,000 by the will of the late Miss Annie Walworth, Cleveland.

MR. JOHN WILLIAM TAYLOR, of Kensington, has bequeathed $100,000 to Owen's College, Manchester, now a part of Victoria University.

PROFESSOR CRUM BROWN has given to the University of Edinburgh a collection of over 2,000 specimens of chemical substances.

THE Japanese minister of education having caused the resignation of one of the professors of the University of Tokyo, owing to his attitude on public questions, the professors of the university have signed a protest, which has led to the resignation of the minister of education and the assumption of his portfolio by the premier. It is said that the position of the cabinet has been greatly weakened by this action of the minister of education.

PROFESSOR C. H. JUDD, of Yale University, has been appointed director of the summer school.

SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

CLOSER RELATIONS BETWEEN TRUSTEES AND FACULTY.[1]

I VENTURE to speak upon the topic: 'Closer Relations between Trustees and Faculty' because I am in this respect hermaphroditic. I have seen service upon both college bodies and, moreover, have studied certain problems of public school administration which present many points of analogy. I speak, however, with only that half-knowledge which we of the east, unfamiliar with state-supported universities, bring to the important questions of this conference.

It is a common cry that teachers—whether in colleges or in schools—are underpaid; and the complaint (especially if one has been a school official) seems amply justified. The imperative need of our American college faculties, however, is not higher salaries; it is larger professional authority and more genuine freedom. Those attained, the wage question will take care of itself. It is true that teaching offers no such money prizes as does law or medicine; nevertheless, the average professor or schoolmaster is in many ways better situated than the average lawyer or physician. Despite this patent fact, the number of youth who deliberately prepare themselves to be teachers, by years of serious study, is comparatively small. Young men of power and ambition scorn what should be reckoned, the noblest of professions, not because that profession

[1] Delivered at the Conference of Trustees of American Colleges and Universities, at the University of Illinois, October 17, 1905.

condemns them to poverty, but because it dooms them to a sort of servitude. The American lawyer or physician is subject only to the judgment of his peers—that is, to the well-established code of his profession. The American teacher, on the contrary, especially in the public schools, is not only subject to—he is often wholly at the mercy of—unsympathetic laymen.

This condition is inherent in the American system of education, and neither can nor should be wholly abrogated. The teacher serves the public (for even an *endowed* college is a public institution) and must rest, therefore, under some of a servant's disabilities. Yet, without impairing the proper powers of school or college trustees, it is possible, I believe, to give teachers—or rather to restore to them—so much of authority, dignity and independence as shall raise teaching to the professional status of the law—to a position, that is, where it will commend itself to the most ambitious and the best-trained youth.

The medieval universities, as you know, were preeminently nurseries and citadels of intellectual freedom and political democracy. They were 'essentially federated republics, the government of which pertained either to the whole body of the masters * * * or to the whole body of the students.' Moreover, 'what slight subordination did exist was, in the beginning, to the ecclesiastical and, later, to the civil power.' The American universities, also, from the frontier college of Harvard, in 1636, to the latest frontier (if there now is any such place) college of the plains—have been strongholds of intellectual freedom; but in their administration they have been profoundly subordinate, in the early days to the ecclesiastical, and later—directly or indirectly—to the civil power.

This subordination, under the stress of circumstances, has progressed until, as President Pritchett points out in a recent admirable address, the American university has become an autocracy, wholly foreign in spirit and plan to our political ideals and little short of amazing to those models of thoroughgoing democracy, the German universities. And this absolutism of the American university is not, as in the days of the scholastics, an autocracy of teachers and scholars; it is an autocracy of ecclesiastical or lay trustees. Whence has arisen this astonishing inversion? Why does the very fountain of our higher life present this paradox? Mainly, I think, because the European universities grew from within, while those of this country have been established from without. The old theocracy of New England, the younger democracies of her splendid daughters, created colleges to fit youth for service in church or commonwealth, and they placed over them men of notable authority. In the east, the hands of both church and state have been largely withdrawn; but in their place have appeared the dead or living hands of donors demanding that their gifts be safeguarded by stable and substantially irremovable trustees. College and public school funds are no less sacred than they are colossal; and those who administer them assume high legal as well as moral responsibility. But this large liability has been more than balanced by the gift of almost absolute powers—powers surpassing, perhaps, those of any other bodies. I do not know how it is here; but in Massachusetts the school boards are virtually despotic, far transcending in authority those sturdy democrats, their parent town meetings.

Excepting those strictly denominational, the balance of the extraordinary legal powers given to college trustees has gradually passed from the hands of the clergy into those of laymen chosen, as a rule, for their standing as financiers rather than as educators. From many aspects this has

been a salutary change; but there has followed from it one signal disadvantage—that of putting the trustees more and more out of touch with the faculties whose members they appoint. Although the reverend gentlemen of those antique college boards could scarcely have distinguished a government bond from a wildcat stock, they were usually scholars by inclination and teachers by profession, and their relations with their faculties were close and sympathetic; while the modern financier who, by skillful investing, secures every possible penny of income for his college, generally finds its educational problems quite outside his range, and sees, therefore, less and less occasion for meeting, or even knowing, that faculty over which, legally, his power is of life and death.

This change in personnel, however, is not alone responsible for the progressive alienation between trustees and faculty. That estrangement has come about, no less, through the rapid growth of college curriculums and in college attendance. When educational institutions were small and their courses of study undifferentiated, it was possible for trustees, even though not trained as teachers, to acquire an admirable education (so far as concerned their own college) through intimate relations with the faculty and personal supervision of their work. But with the enormous development in numbers and complexity, this old-fashioned contact between trustees and teachers has become impossible, and, at best, a trustee can now make himself familiar with only that department of the university which it is his duty (more honored in the breach than in the observance) to inspect. Therefore, the modern trustee has gradually withdrawn from the teaching side of the college to fix his attention upon those questions of revenue, housing and legislation which have multiplied even faster than the undergraduates.

But here again the size and complexity of the problem are appalling to men already overweighted with other responsibilities. These material questions, however, must be met and settled just as those on the educational side must be faced and solved. And both business and political experience have taught men of the world that the quickest and least troublesome way to solve administrative problems is to give as free a hand as possible to some man with brains, with tact, with power of initiative, of leadership, and of persuasion—with, in short, those peculiar abilities which distinguish the generals of our intricate twentieth century enterprises.

Hence has arisen the modern college president—a being as different from the awe-inspiring clergymen of the eighteenth century or from such men as Josiah Quincy (who was given the presidency of Harvard as a sort of haven for his declining years) as it is possible to imagine. The modern executives have had thrust upon them powers which give to their decrees the finality of an imperial ukase. They have assumed such sway, not from love of dominion, but because their task is so enormous that nothing short of practically plenary powers would permit of its being done at all. And it should be said to their honor that they have met the demands upon them as organizers and administrators so ably that, today, the leaders of the country are not, as formerly, the great statesmen and clergymen; they are these modern Cæsars—the heads of our principal colleges and universities.

These modern presidents have their cabinets in the board of trustees (if that board be small) or in an executive committee selected from it if the board be large; they have their staff in the several administrative officers, such as deans and registrars; they have their field officers in the heads of departments or courses; and the work

of the great machine, through committees, sub-committees, labor-saving devices and automatic methods of reporting, is as smooth-running (and sometimes, I fear, almost as impersonal) as a well-developed mercantile establishment. We have here a conspicuous example of the current tendency towards one-man power, towards that concentration of authority which makes, of course, for ease, rapidity and sureness of administration; but which, in politics, undermines manhood; in industrialism, destroys initiative; and in education tends to defeat the very object of teaching, which should be to develop and make the most of every man's individuality. If the goal of a college were the giving of mere instruction, nothing could be better than the present system of administration; but colleges should be fountains of true education, and the best part of education comes through the personal influence of the older governors and teachers upon adolescent, and therefore highly impressionable, youth.

Most modern colleges have expensive and excellent material plants utilized substantially to their full capacity. They possess, also, admirable executives who, as I have said, are used away beyond their limits of endurance. But those colleges have also other educational forces which are not availed of, in my opinion, to anything like their normal maximum. Those less used forces are: (1) The personal influence, as teachers and men (not as mere administrators) of the leaders of the faculty—an influence which should be exerted upon both students and trustees; (2) the personal influence, as men of power and broad human experience (not as mere money-holders) of the trustees—an influence which should extend to students as well as faculty; and (3) the perennial and unselfish loyalty of the alumni, together with the unique experience given to those graduates in gauging their collegiate training by the tests of life. The third force is beyond the scope of the present paper; but let it not be inferred, therefore, that I regard it as any less potent than the other two. Indeed, in the last analysis, the moral as well as the financial strength of a college must come from its own sons.

As has already been suggested, the complexity and autocracy of the American university have converted the strongest men of the faculty—the men, therefore, whose personal influence upon the students would be of the highest value—into subordinate administrators harassed with details of department maintenance and committee attendance. As a necessary result, the teaching is put largely into the hands of recently graduated youth, zealous but not always wise, untrained in the science and art of teaching, and quite incapable, of course, of giving to their classes the inspiration which comes from contact with men of wide experience. This throws the severest strain of the college upon the weakest part, and from it arises much of our educational ineffectiveness. Mere information, lesson-hearing, examinations, become paramount; scholarship and character are well-nigh forgotten, being impossible to register by even the most elaborate machinery.

The trustees, on the other hand—excepting those who constitute the president's cabinet—find less and less opportunity for usefulness in a machine so elaborate that any incursion into it, by those unfamiliar, may do infinite harm. Therefore most of them drift into the belief that their trust is discharged by attendance upon stated meetings and by, perhaps, an annual visit to that department which, nominally, is their especial care. Yet the personal influence upon the students of men like college trustees would be second only, in educational value, to that of the leading members of the faculty. I am not prepared to sug-

gest any plan by which the trustees can be brought into direct personal relations with the students; but I firmly believe that such a plan could be devised; and I know that nothing so vivifies a man of middle life and of large responsibilities, nothing so clears his brain and rejuvenates his heart, as comradeship with bubbling and eager undergraduates.

Whether or not trustees can broaden their powers and sweeten their responsibilities by thus meeting their students directly, it is clear that they can influence them indirectly by establishing closer relations with those young men's teachers. For their pupils' sakes and for their own advantage, the professors need the stimulus and the breadth of view which they would get from looking at the world through the eyes of such a man of affairs as the usual trustee; those trustees, on the other hand, need the insight into true education and into the difficulties of training youth which they would secure from intimate contact with the members of their faculty. The money conservatism of the trustee, hesitating to grant funds for new enterprises, needs to be enlightened by the vision which the teacher has of the demands and possibilities of higher education. *Per contra,* the academic conservatism of the scholar needs to be quickened by the hard world-experience of a man of more varied responsibilities. That purblind vision of the 'practical' man which exaggerates material success requires enlightenment through the opposite, but no less purblind, vision of the scholar which magnifies intellectual achievement. Each point of view is essential to the ends of true education, and unless each in authority can see and understand the other's outlook, the university will suffer and its youth will be defrauded of some of the best things in college.

At present—except for certain perfunctory visiting—almost the sole point of contact between trustees and faculty is their common sovereign, the president, who, as I have tried to show, has administrative duties and responsibilities beyond normal powers. Moreover, however conscientious he may be, his personal equation can not but enter into his interpretations—so to speak—between two bodies of which he alone is a common factor. It is essential to his leadership that he should have large powers over the teaching staff, but the opinions of the most perfect of administrators as to the individuals under his benevolent despotism should have the salutary check of others' close and unbiased observations.

In order, therefore, that there may be many instead of only one channel of understanding between trustees and faculty (as well as for the more subtle reasons suggested earlier), I would advocate most earnestly the creation in every board of trustees of a new standing committee. This committee should be most carefully chosen, and its duty should be to confer, at stated and frequent intervals, with a like standing committee of the faculty, selected freely by that body itself. And I would advise, further, that this conference committee be distinct, if possible, from that executive committee which I have called the president's cabinet, and that no legislation of any consequence should be passed by the executive committee or by the trustees as a whole without the concurrence of this joint committee. And—at least so far as relates to questions having any educational bearing—I would have it understood that the joint committee should *not* concur until the proposed action had been submitted to the faculty as a whole, had been debated, if so desired, before the standing committee and the executive committee sitting in joint session, and had been approved by at least a majority of the teaching staff.

Such a general plan as this (the details of which, needless to say, would differ with each college) could not fail, it seems to me, to increase the educational efficiency of a college to an extraordinary degree, by coordinating the views of those without and those within the daily routine of teaching; by establishing a clear understanding, in each body, of the other's problems; by relieving the executive of a substantial portion of his crushing load, through increasing the legislative and administrative responsibility of the faculty; and, not least, by making that faculty—without adding to its legal powers—a body coordinate with, instead of subordinate to, the board of trustees. Unless American college teachers can be assured by some such change as this that they are no longer to be looked upon as mere employees paid to do the bidding of men who, however courteous or however eminent, have not the faculty's professional knowledge of the complicated problems of education, our universities will suffer increasingly from a dearth of strong men and teaching will remain outside the pale of the really learned professions. As I said in the beginning, the problem is *not* one of wages; for no university can ever become rich enough to buy the independence of any man who is really worth the purchasing.

This plan of cooperation would not, however, except to a limited degree, bring the trustees as men into close contact with the faculty as men. And the plan which I offer towards that second aim is put forward with much greater diffidence. The scheme of a joint standing committee would be productive, I feel certain, of most happy results; but of my minor proposition I am not so sure. This second plan is to make every member of the board of trustees an administrative officer in that branch of the college work (so far as possible) which is most congenial to him, giving him no special individual powers over his assigned department, but increasing his responsibilities by making him—together with one or more of his colleagues—the direct and responsible channel of information between that department and the whole board of trustees. It is already customary in most colleges to create visiting committees with the duty of presenting annual reports; my suggestion would make substance out of what is now little more than shadow, by having it formally understood that in all matters relating to his department the trustee would be looked to for reliable information and responsible advice.

Difficulties, of course, stand thick in the way of such a project. Among them are the unwillingness of already busy trustees to accept further responsibilities, the danger of personal friction between the trustee and the department head, and the natural fear on the part of the teacher that 'administration' might spell itself to the trustee as mere officiousness. It seems to me, however, that a short acquaintance with the minutiæ of a college department would show the trustee that the professor's as well as his own time is far too valuable to be given to details of administration, and that college funds could in no way be made more productive than by giving the heads of departments such clerks and underlings as would release them from much killing drudgery. There is no greater extravagance than to permit an expensively trained man to do ten-dollar-a-week work. And that same short acquaintance would, I believe, so interest the trustee and so increase his respect for what is being done and what is still to do, that officiousness or meddling would become impossible.

These two plans, if found practicable and if developed in a spirit of enthusiasm,

would lead to many other points of helpful contact between trustees and faculty and would discover, I think, unsuspected avenues of mutual help. And by these or some like methods trustees and faculties must be brought more closely together unless we wish to see the growing alienation of the administrative and teaching staffs develop into a real and fatal breach. Separation involves mutual misunderstanding and that, even among educated men, leads, as in industrial enterprises, to arrogance on the part of the employer, to suspicion and dislike on the side of the employed. If cooperation seems imperative—as I think it does—to the solution of the problems of industrialism, how much more necessary is it if we are to solve the educational riddle. Cooperation would teach the trustees the antipodal difference between the problems of a university and those of a business corporation, and, at the same time, would show the faculty the importance of business methods and thorough organization. Cooperation would get things done without compelling our universities to take refuge in an autocracy which, harmful in itself, is breeding a race of youth who scorn the slow methods of democracy. It would develop trustees who actually, instead of fictitiously, comprehend and apprehend their trust; it would unite faculties which, under the strain of departmental complexity, are fast disintegrating; it would double the educational efficiency of our colleges; and, most important of all, it would make our universities, as they ought to be, supreme preservers, instead of conspicuous destroyers, of that genuine spirit of democracy which, more than schools, more than churches, more than any other human agency, has uplifted mankind and builded civilization.

JAMES P. MUNROE.

THE BIOLOGICAL LABORATORY OF THE BUREAU OF FISHERIES AT WOODS HOLE, MASS.: REPORT OF WORK FOR THE SUMMER OF 1905.

I. STAFF EQUIPMENT, ETC.

THE laboratory was in service for purposes of investigation during a period of somewhat over three months, commencing June 15. In addition to the crews of the vessels and the permanent force of the station, forty-three persons were directly or indirectly engaged in the furtherance of scientific research. Of this number, thirty are to be classed as investigators, their individual work being detailed below. Of these thirty, fifteen received a salary from the bureau, the remaining fifteen being unpaid. The staff of the laboratory consisted of a director, together with twenty-two others officially listed as 'temporary assistants'; and a librarian, clerk and janitor detailed from the office force at Washington. Of those classed as 'temporary assistants' six were occupied primarily in connection with the biological survey; five others in individual investigations conducted on behalf of the bureau; the remainder being engaged in miscellaneous work in laboratory, residence or field. Those who devoted the whole or part of their time to biological work requiring previous training have been included among the investigators.

The steam vessels *Fish Hawk, Phalarope* and *Blue Wing* were, as usual, in service during a large part of the season, and the much valued collection of biological works belonging to Brown University was again placed at the disposal of the laboratory.

Material for research was furnished by the dredging operations of the *Fish Hawk* and *Phalarope,* by the laboratory fish trap in Buzzards Bay, and by the large group of traps at Menemsha Bight, Marthas Vineyard, where a camp was established for

about six weeks. Special collecting trips for particular sorts of material were, of course, frequently made.

The plan was continued of holding informal weekly meetings devoted for the most part to reports upon researches in progress at the laboratory. Papers were presented by Messrs. Bigelow, Cushman, Gulick, Hargitt, Linton, McClendon, Stockard, Sullivan, Sumner and Thompson. These meetings were as a rule well attended by outsiders as well as by the investigators of this laboratory.

II. BIOLOGICAL SURVEY.

This was brought to such a point that a preliminary report upon the fauna and flora of the sea-bottom of this region might be profitably undertaken without further dredging work. It is hoped that the publication of such a report will be possible within a year or two.

The *Fish Hawk,* under command of Lieut. Franklin Swift, U.S.N., was engaged during a part of July in reestablishing the former coast survey tripods upon Marthas Vineyard and the Elizabeth Islands. Following this, a considerable portion of the bottom of Vineyard Sound, already dredged during the summer of 1903, was once more explored. The new dredging stations, being located by the aid of the coast survey signals, could be charted with far greater accuracy than had hitherto been possible. The extreme eastern portion of the sound, which had previously been left out of consideration, was likewise covered by the dredge. In all 101 'stations' were established by the *Fish Hawk* during a period of about six weeks. The dredging work of this vessel, together with the cataloguing of material thus obtained were under the supervision of Mr. L. J. Cole.

The *Phalarope,* under the direction of Mr. R. C. Osburn, worked in the shallower waters of Buzzards Bay, completing the entire eastern shore-line, from Cuttyhunk northward to Wareham.

Most of the material obtained by the dredge was identified in the laboratory by those in immediate charge of the work, with the voluntary cooperation of a number of systematists who were engaged in studies at the station. Thus the Foraminifera were determined by Mr. B. A. Cushman, who has likewise undertaken the identification of the sponges; the hydroids were referred to Professor C. W. Hargitt, the annelids to Dr. J. P. Moore, and the decapod crustaceans to Miss M. J. Rathbun. Considerable other material, however, still awaits disposal.

A camp was maintained at Menemsha Bight, Marthas Vineyard, for a period of about six weeks in July and August, three assistants at a time being detailed for this work. The numerous fish traps of this region were visited, and a daily record was kept of the species therein taken. Much material of value was likewise supplied to the laboratory for the use of various investigators, and several species of especial interest were taken, including a small specimen of the great blue shark (*Prionace glauca*), the only one recorded for this region within twenty-eight years. The torpedo (*Tetranarce occidentalis*) and the goose fish (*Lophius piscatorius*) were at one time rather common, and large specimens of the former species were kept on exhibition in the aquaria tanks.

An account of the collecting work at this station is never complete without mention of the labors of Mr. Vinal Edwards, whose well-directed search for fishes, fish parasites, plankton, etc., has made possible many of the most important contributions from the laboratory.

III. INDIVIDUAL INVESTIGATIONS.

The investigators were thirty in number,

representing eighteen educational and scientific institutions, ranging from Boston to the Pacific Coast, and from Florida to Montreal. Of these Harvard furnished eight, Columbia five, the University of Pennsylvania and the College of the City of New York two each.

The subjects of research may be somewhat arbitrarily classified as follows, allowing for the fact that certain investigators devoted their time to more than one subject:

Reactions to stimuli, animal behavior, etc.	9
Faunal and floral distribution (including survey work)	7
Taxonomy	6
Embryology	3
Ecology (exclusive of distribution)	2
General Physiology (exclusive of 'behavior')	2
Regeneration	2
Miscellaneous	6
	37

While much of this work is calculated to be of ultimate value in the solution of practical fisheries questions, it is true that little of it has in view immediate and obvious economic results. The most notable exception is a study of the potential food value of various unused or little-used marine organisms. This liberal attitude toward biological investigation is one of the traditions of the United States Fish Commission and its successor, the Bureau of Fisheries, which have never failed to recognize the vast indebtedness of industry to pure science.

In addition to those who have been listed as investigators, two painters of animal life, Messrs. Chas. R. Knight and S. F. Denton, made use of the facilities of the laboratory for a part of the season.

Robert P. Bigelow, Ph.D., instructor in biology, Massachusetts Institute of Technology: systematic study of the stomatopods collected by the steamer *Albatross* (continued).

Leon J. Cole, assistant in zoology, Harvard University: Biological survey of local waters. Mr. Cole had immediate supervision of the dredging work of the steamer *Fish Hawk,* and of the preservation and identification of material incidental thereto (salaried assistant).

Joseph A. Cushman, assistant curator, Boston Society of Natural History: Systematic study of the Foraminifera collected during the dredging operations of the steamers *Fish Hawk* and *Phalarope;* likewise collection of local marine ostracods for future identification.

Bradley M. Davis, Ph.D., assistant professor of botany, University of Chicago: Local marine flora. Dr. Davis continued his services in the capacity of botanist of the biological survey (salaried assistant).

Donald W. Davis, Harvard University: Dredging work of biological survey; also at Menemsha Camp (salaried assistant).

Pauline H. Dederer, lecturer in zoology, Barnard College, Columbia University: Studies upon the larval development of *Amarœcium.*

Irving A. Feld, Austin teaching fellow in zoology, Harvard University: (1) Further investigations of the food of certain fishes (principally *Raja erinacea*); (2) the food value of some hitherto unused or little used marine animals (fishes, crustacea and molluscs), tested by various cooking methods (*e. g.,* steam, under pressure); (3) experiments to determine the effect of concussions caused by gun-fire upon fishes (salaried assistant).

Alexander Forbes, A.M., graduate student, Harvard University: Experiments upon the attachment of oysters.

William K. Gregory, A.M., assistant at American Museum of Natural History: Comparative anatomy of local teleost fishes.

Addison Gulick, A.M., graduate student, Harvard University: (1) Experiments upon chemical sense of *Sycotypus canalic-*

ulatus, together with inquiry into the functions of the osphradium; (2) collection of material for future study of the glandular organs of molluscs.

Chas. W. Hargitt, Ph.D., professor of zoology, Syracuse University: Preparation of a synopsis of the Anthozoa of the Woods Hole region. This work will form one of the series of reports upon special groups of local fauna, issued at intervals by the Bureau of Fisheries (salaried assistant).

Trevor Kincaid, A.M., professor of zoology, University of Washington: Sporozoa of local marine invertebrates.

Edwin Linton, Ph.D., professor of biology, Washington and Jefferson College: The parasites of fishes, chiefly entozoa (salaried assistant).

J. F. McClendon, M.S., fellow in zoology, University of Pennsylvania: The early stages in the development of various parasitic copepods.

Hanford McCurdy, graduate student, Harvard University, instructor in biology, Manual Training School, Kansas City, Mo.: The reactions of *Pennaria tiarella* and *Eudendrium ramosum* to various stimuli; also experimental studies upon the nervous systems of local crabs.

A. G. Mayer, Ph.D., director research laboratory of Carnegie Institution, Dry Tortugas, Fla.: Experimental studies upon medusae.

J. Percy Moore, Ph.D., instructor in zoology, University of Pennsylvania: Synopsis of local annelids (for the bureau) (salaried assistant).

Chas. V. Morrill, graduate student, Columbia University: Dredging work of biological survey, likewise experiments upon regeneration of fishes (salaried assistant).

Max Morse, graduate student, Columbia University: (1) Dredging work, etc., (2) experiments upon autotomy of 'head' in *Tubularia crocea* (salaried assistant).

Raymond C. Osburn, instructor in zoology, New York High School of Commerce; graduate student, Columbia University: Biological survey of local waters. Mr. Osburn had direct supervision of the dredging work of the steamer *Phalarope* (salaried assistant).

A. S. Pearse, A.M., graduate student, Harvard University: The reactions of *Tubularia crocea* to various stimuli.

Mary J. Rathbun, assistant curator U. S. National Museum: Studies of habits of local decapod crustacea.

Carl D. Sawyer, medical student, McGill University: Studies of fish parasites (assisting Professor Linton) (salaried assistant).

G. G. Scott, A.M., tutor in anatomy and physiology, College of the City of New York: (1) Morphology of the tracheal system of a dragon-fly nymph; (2) relation of the central nervous system to regeneration in *Fundulus heteroclitus* (salaried assistant).

A. B. Seymour, Cambridge, Mass.: Studies of marine algæ of Woods Hole.

Chas. R. Stockard, M.S., graduate student, Columbia University: The effects of lithium chloride upon the development of the egg of *Fundulus heteroclitus.*

Michael X. Sullivan, Ph.D., instructor in chemical physiology, Brown University: (1) The physiology of the digestive tract in certain fishes; (2) the rectal gland in certain fishes (salaried assistant).

Francis B. Sumner, Ph.D., instructor in zoology, College of the City of New York; director of the laboratory: (1) Biological survey of local waters; (2) the physiological effects of changes in water density and salinity upon fishes. (Last shortly to be issued by the bureau.)

Millett T. Thompson, Ph.D., instructor in zoology, Collegiate Department, Clark University: The decorating instinct of

spider crabs (*Libinia emarginata* and *L. dubia*).

Herbert E. Walter, A.M., assistant in comparative anatomy, Harvard University: (1) Reactions of a triclad worm (*Bdelloura candida*) to light; (2) statistical study of the variability of the gastropod *Urosalpinx cinerea* from various points in the vicinity of Woods Hole.

FRANCIS B. SUMNER.

CONVENTION OF THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

THE association met at Washington for its nineteenth annual convention, November 14–16, 1905. Being preceded and followed by a number of other conventions, among which were those of the Associations of State Universities, of Farmers' Institute Workers, of Horticultural Inspectors and of Official Agricultural Chemists, an unusually large number of persons interested in industrial education and agricultural experimentation was brought together in Washington, and this tended to make the convention of agricultural colleges and experiment stations one of the largest ever held. The association was addressed by the Hon. James Wilson, secretary of agriculture, who declared his deep interest in the work carried on by the institutions represented in the association, and indorsed the movement to secure an increase in the appropriation for the experiment stations, to which he pledged his support.

The annual address of the president of the association, delivered by Dr. E. B. Voorhees, director of the New Jersey experiment stations, related in the main to some of the duties and responsibilities of the agricultural colleges and experiment stations. Dr. Voorhees held the colleges primarily responsible for the character of work done by the experiment stations, because the working staff is the first determining factor in station work, and the colleges must be depended on to furnish the fundamental training for this work. He urged the need of more research work on the part of the stations, and declared that the present limitations were largely due to the insufficient supply of broadly trained men competent to conduct highly scientific investigations in agriculture.

A memorial address upon the life and services of President Henry H. Goodell, of the Massachusetts Agricultural College, and for many years a prominent worker in the association, was delivered by President W. E. Stone. President Goodell's death occurred last spring.

There were the usual reports of officers of the association and of standing committees. The executive committee reported that it had succeeded during the year in securing modification of the orders of the War Department with reference to military instruction in the land-grant colleges. The same committee suggested a reorganization of the standing committees of the association, which was taken up later and was one of the important actions of the association. Four standing committees were provided for, viz., (1) instruction in agriculture, (2) graduate study, (3) extension work and (4) experiment station organization and policy. The committees consist of six members each, and there is provision for a gradual rotation in the membership, the terms of only two members expiring each year.

Dr. A. C. True presented the report of the committee on indexing agricultural literature, describing the progress which has been made by the library of the Department of Agriculture in indexing scientific periodicals relating to agricultural investigations. The index is printed on cards. This undertaking has grown out of the efforts of the committee. Dr. True also presented the report of the committee on

methods of teaching agriculture, outlining the future work of the committee and mentioning the proposed extension of the studies in matters relating to agricultural education in the Office of Experiment Stations, an appropriation for which has been recommended to congress.

The committee on graduate study reported, through Professor L. H. Bailey, that arrangements had been made for holding the second session of the school of graduate study at the University of Illinois during the coming summer. The association took more definite action in fixing the relations of this school, adopting it as a regular part of its work and assuming responsibility for its maintenance and success. Contributions from the various agricultural colleges have been pledged toward the support of the school.

There was considerable discussion of the bills before the last congress providing increased endowment for the agricultural experiment stations and for the establishment of mining schools, and the association instructed its executive committee to lend its aid toward securing the passage of these bills, and especially that providing additional funds for the experiment stations. The committee was also instructed to secure if possible the establishment of a department of agricultural education in the National Educational Association.

SECTION ON COLLEGE WORK AND ADMINISTRATION.

The general theme for discussion before this section was 'The Field and Functions of the Land-Grant Colleges,' which was considered under the heads—curriculum, discipline and environment. The program included papers upon 'A Minimum General Culture Requirement,' by President A. B. Storms; 'Relative Amounts of Pure and Applied Science,' by President J. M. Hamilton; 'Courses in Agriculture, Horticulture and Allied Subjects,' by Professor F. W. Rane; "What is a 'Liberal and Practical Education' for an Engineer?" by Dr. H. W. Tyler; 'A Degree Course in Home Economics,' by President W. E. Stone; 'What Ought a Degree Course in Home Economics to Include?' by President J. L. Snyder; 'Student Control,' by President W. O. Thompson; and the relations of the land-grant colleges to—(1) the state universities, by President W. J. Kerr, (2) the normal schools, by President K. C. Babcock, (3) the public schools, by Dr. A. C. True, and (4) the farmers, by Professor John Hamilton.

Throughout the discussion in this section there was apparent unanimity of opinion that the land-grant colleges should offer courses equal in educational value to those of other institutions granting degrees, that industrial subjects properly taught have a high educational value, and that the college courses should not be narrow or severely technical. There was also recognition of the fact that the function of the land-grant college includes more than the conducting of degree courses. These colleges should lend their aid, through cooperation with other established institutions and in other ways, to the establishment and development of efficient secondary and elementary courses in agriculture and the mechanic arts in the public schools or in special schools, supplementing their four-year courses with short courses and other forms of extension work until the work of the secondary and elementary schools is well established. They should also continue, so far as their resources will allow, the extension work intended to reach adult farmers and others unable to attend school.

SECTION ON EXPERIMENT STATION WORK.

There were two main themes considered by this section—a series of papers upon 'Soil Investigations,' and a general discussion upon the subject 'How Much Demon-

stration Work and What Kind should the Experiment Station undertake?' Under the first subject Dr. C. G. Hopkins presented a paper on 'Soil Fertility in Relation to Permanent Agriculture,' in which he outlined the method followed in Illinois in studying the problems of fertility and the fertilizer requirements, summarizing the results obtained and introduced into practise. Dr. A. M. Peter presented 'Some Results of an Old Method for Determining Available Plant Food in Soils,' giving the results upon virgin soil, old field soil and subsoil. He pointed out the weaknesses of the method and recommended a modified method, for which he gave a series of results. Director C. E. Thorne, in a paper on 'Soil Investigation,' pointed out the necessity of supplementing chemical analysis and pot experiments with carefully conducted field experiments, and also of giving more attention to the biological processes of the soil; and Dr. H. J. Wheeler described some of the lines of soil investigation in progress at the Rhode Island Experiment Station, making suggestions regarding profitable lines of research to be undertaken in this field.

The discussion upon the subject of demonstration work developed some difference of opinion as to the advisibility of the experiment stations undertaking such work, although its usefulness was freely acknowledged. A clear distinction was drawn between experimental and demonstration work, and the general opinion was advanced that the demonstration work was more strictly an education phase which might very properly be undertaken by other agencies, leaving the stations free to confine their efforts quite largely to experimentation and research. Considerable demonstration work is now carried on by the experiment stations, and this work is a necessary supplement of the present system of investigation and dissemination.

The association received an invitation to hold its next meeting in California, prior to or following the meeting of the National Educational Association. Considerable interest was manifested in this matter, an objection to the plan being that it might conflict with the proposed graduate school if held during July. The matter was left with the executive committee.

In the election of officers President M. H. Buckham, of Vermont, was chosen president; President C. C. Thach, of Alabama, Dr. E. H. Jenkins, of Connecticut, and Presidents J. H. Worst, of North Dakota, B. I. Wheeler, of California, and Luther Foster, of New Mexico, vice-presidents. Director J. L. Hills, of Vermont, was reelected secretary-treasurer; Dr. A. C. True, of the Department of Agriculture, bibliographer; and Dr. H. C. White, of Georgia, President J. L. Snyder, of Michigan, Dr. W. H. Jordan, of New York, Director C. F. Curtiss, of Iowa, and Director L. H. Bailey, of New York, members of the executive committee. President C. R. Van Hise, of Wisconsin, was chosen chairman, and President H. C. Price, of Ohio, secretary, of the section on college work and administration; and Director B. C. Buffum, of Wyoming, chairman, and Director M. A. Scovell, of Kentucky, secretary, of the section on experiment station work.

E. W. ALLEN.

WASHINGTON, D. C.

SCIENTIFIC BOOKS.

JORDAN'S GUIDE TO THE STUDY OF FISHES.[1]

IN 1880, ten years after completing his great 'Catalogue of the Fishes in the British Museum,' Guenther published his 'Introduction to the Study of Fishes,' a book of 720 pages which gives 'in a concise form an ac-

[1] Jordan, David Starr, 'A Guide to the Study of Fishes,' 2 Vols., small quarto, pp. xxvi + 624 and xxii + 599. 2 colored frontispieces and 899 illustrations. New York, Henry Holt & Co., 1905. $12.00 net.

count of the principal facts relating to the structure, classification, and life history of Fishes' and is 'intended to meet the requirements of those who are desirous of studying the elements of Ichthyology; to serve as a book of reference to zoologists generally; and, finally, to supply those who, like travelers, have frequent opportunity of observing fishes, with a ready means of obtaining information' (preface). Guenther's 'Introduction' has continued the only work of its sort. Indeed, of comprehensive works on fishes, there have appeared, aside from popular natural histories, only Dean's excellent 'Fishes, Living and Fossil' (1895), a strictly morphological work, and the seventh volume of the 'Cambridge Natural History' (1904), containing Bridge and Boulenger's admirable 620 pages on fishes. The latter treatise is almost as extensive as Guenther's 'Introduction' and will largely supersede it.

In 1900 President Jordan (with Dr. Evermann) completed his monumental but strictly systematic 'Fishes of Middle and North America.' In 1902 he (again with Dr. Evermann) published the popular 'American Food and Game Fishes.'

The present work, the first large work on fishes to be independently undertaken by the writer, is of nearly twice the extent of Guenther's 'Introduction' or of the 'Cambridge Natural History' and like them "treats of the fish from all the varied points of view. * * * The writer has hoped to make a book valuable to technical students, interesting to anglers and nature lovers, and instructive to all who open its pages" (preface). In scope and in the circumstances leading up to its writing Jordan's book suggests comparison with Guenther's. Like its predecessors, it falls into two parts. The first twenty-four chapters (459 pages) form an introductory or general treatise on fishes while the remainder of the work deals descriptively with the various subdivisions of the group. The following chapter headings indicate the scope of the general part: I., The Life of the Fish; II., The Exterior of the Fish; III., The Dissection of the Fish; IV., Skeleton; V., Morphology of the Fins; VI., Organs of Respiration; VII., Nervous System; VIII., Organs of Sense; IX., Organs of Reproduction; X., Embryology and Growth; XI., Instincts, Habits, and Adaptations; XII., Adaptations; XIII., Colors; XIV., Geographical Distribution; XV., Isthmus Barriers Separating Fish Faunas; XVI., Dispersion of Fresh-water Fishes; XVII., Dispersion of Fresh-water Fishes, continued; XVIII., Fishes as Food for Man; XIX., Diseases of Fishes; XX., Mythology of Fishes; XXI., Classification; XXII., History of Ichthyology; XXIII., The Collection of Fishes; XXIV., The Evolution of Fishes (paleontological).

The author's interests as a taxonomist and student of geographical distribution seem to be reflected in his allotment of space. Thus in chapters I. to V. and XII. and XIII., about 134 pages, or nearly one third of the general portion, are devoted chiefly to the external morphology and the skeleton, the structures most used by the systematist. Geographical distribution occupies 83 pages and the history of ichthyology 42. The subjects mentioned thus take up more than one half of the introductory part of the book. On the other hand, respiration is dismissed with 18 pages, the nervous system and sense organs with 15 and the reproductive organs with 7, while five lines are given to the kidneys and they are not referred to in the index. The 'Cambridge Natural History,' with but half the space of the present work, gives 36 pages to respiration, 30 to the nervous system and sense organs and 24 to the urinogenital organs. While it is true that external features and particularly external adaptive features are of peculiar interest to the general reader, yet much that President Jordan has included on the skeleton and external morphology is not treated from the point of view of adaptation and is probably of less general interest than much that might have been added on internal structures.

In writing that the book is meant for technical students, anglers and nature lovers, the author clearly does not wish us to understand that all parts of it have been so written as to be useful to each of these classes of readers, but

rather that each will find in it much of interest and value. In truth the style is very unequal. The first three or four chapters and chapter sixteen, as well as many other portions, are models of clearness and simplicity and are of use to the general reader as well as to the specialist, while portions of the chapter on the morphology of the fins and of other chapters will hardly attract the nature lover. This inequality of matter arises largely from the fact that while a part has been prepared especially for this book and with reference to all the classes of readers mentioned, much of it has been quoted from more or less technical sources. Thus much of the chapter on the morphology of the fins is quoted from technical papers of Ryder, Kerr and Gill. The chapters on geographical distribution and on the history of ichthyology are, with little modification, reprinted from earlier papers of the author, some of them published in this journal. The chapter on color is from a paper of the author in the *American Naturalist* and that on collecting from a paper in the *Popular Science Monthly*. Most of the chapter on diseases is quoted from American authors, but Hofer's valuable 'Handbuch' is ignored.

So on the first page we read:

> If we would understand a fish, we must first go and catch one. This is not very hard to do, for there are plenty of them in the little rushing brook or among the lilies of the pond. Let us take a small hook, put on it an angle worm—no need to seek an elaborate artificial fly—and we will go to the old 'swimming hole' or the deep eddy at the root of the old stump where the stream has gnawed away the bank in changing its course.

This may savor of the nature-study leaflet but is clear withal and meaty. On the other hand, we have this quotation from Gill:

> The two elements of the arch, named by Parker, in *Lepidosiren*, 'supra-clavicle' (scapula) and 'clavicle' (ectocoracoid) seem to be comparable together, and as a whole, with the single element carrying the humerus and pectoral fin in the Crossopterygians (*Polypterus* and *Calomoichthys*) and other fishes, and therefore not identical respectively with the 'supraclavicle' and 'clavicle' (except in part) recognized by him in other fishes. (I., p. 89.)

Would not the book have been more readable for all had the author adhered to the plan with which he seems to have set out, that of presenting the whole subject in non-technical form and in his own clear and forceful language?

An examination of the general part of the book as to its scientific quality shows the same unevenness as in style and in the distribution of space. The chapters dealing with the internal organs (exclusive of the skeleton) omit much. Brüning's fundamental work on the physiology of the circulation of fishes has not been made use of. The account of the nervous system (chapter VII.) does not mention the thalamencephalon as one of the subdivisions of the brain, does not call attention to the distinctive features of the brain which result from the presence of the nervus lateralis and does not mention the lateralis. The account of the nervous system is then that of the elementary text-book of comparative anatomy of ten years ago, and includes nothing of the important and accessible recent work of Herrick, Johnston and other Americans.

The account of the eye does not discuss its most striking peculiarities worked out ten years ago by Beer,[2] and perpetuates an old error of Plateau, found in nearly all text-books, in the statement that the cornea is 'little convex,' though Beer showed that this is not the case.

One is left with a hazy impression of the sense of hearing in fishes after reading the contradictory statements on pages 115, 121 and 122; and this in spite of references to Parker's recent work. The sense of taste is dismissed with a paragraph and Herrick's important and most interesting work is not mentioned, nor are his results utilized.

A good deal of space is given to the subject of color, and yet the reader is likely to be left with an indefinite and in some respects erroneous notion of the cause of colors and the

[2] Beer, Th., 'Die Accommodation des Fischauges,' *Pflüger's Archiv*, LVIII., 523–650.

mechanism of color changes in fishes. We are told (I., p. 8) that changes in the position of the scales produce color changes; 'when they rise a little the color seems to change.' 'Fine lines and concentric striæ on the scales' are said to produce a bluish luster, although there is 'no real blue pigment' under them (I., p. 9). Again (I., p. 226) 'certain metallic shades, silvery blue or iridescent, are produced, not by actual pigment, but, as among insects, by the deflection of light from the polished skin or the striated surfaces of the scales.' And yet there are several references to blue pigment (I., pp. 8, 9, 129, 155). Pouchet[3] showed more than thirty years ago that the blue colors of fishes were due, not to the structure of the scales, but to a layer of cells containing guanin crystals, and to these cells he gave the name of iridocytes. Cunningham and McMunn,[4] though differing from Pouchet in details, reached the same conclusion. The pigments of fishes are lipochromes (red, orange, yellow) and melanin (black), not blue. All this is accurately and fully set forth in the 'Cambridge Natural History.' Moreover, Camichel and Mandaul[5] have recently made the general statement that in vertebrates all blue skins contain no pigment but black, and all green skins no pigment but black and yellow.

These are, to be sure, in a sense errors of omission, but there are other errors not of this sort. Thus we are told (I., p. 91) that the labyrinthine apparatus of *Anabas scandens* is a 'contrivance for holding water above the gills,' though Zograff[6] showed the apparatus to be for the purpose of holding air for respiration. Here again the 'Cambridge Natural History' would have furnished accurate information. On page 107 arterial bulb and conus arteriosus are used as synonyms. One of the strangest errors is in the statement (I., p. 118) that in the deep sea form *Ipnops* 'the eyes are spread out to cover the whole upper surface of the head, being modified as luminous organs.' This was Moseley's original opinion, but, as he states in his final paper,[7] it arose from the fact that among the sections of *Ipnops* given him for examination there was an unlabeled slide 'containing a section of the retina of some ordinary teleostean fish.' His final examination showed him that the 'peculiar organs have in reality no connection with organs of vision. The eyes as well as the optic nerves are entirely aborted in the fish.'

These instances from the general part of the book show that it can not be uniformly depended upon to present a full, accurate and modern account. On the other hand, the chapters on distribution, classification and the history of ichthyology do not appear to err in any of these directions. These subjects are treated with so great fullness and knowledge that nothing equal to them is to be found elsewhere. The chapters on distribution have the rare merit of relating the distribution to the topography and recent geological history of the regions discussed and are to be commended for their wise conservatism. The chapters dealing with the external structural features and that on paleontological history, though less technical, are usually clear and well suited to various classes of readers.

The descriptive portion of the book (somewhat more than one half) follows the method long familiar to American zoologists in Packard's 'Guide to the Study of Insects.' The salient characters of each family or larger group are given and are followed by a running and often gossipy comment on its commoner or more interesting representatives. There are no keys or specific descriptions, so that for determining species President Jordan's other books should be used. There is much difference of opinion among naturalists as to the value of this mode of treatment. While it affords much of interest to the technical student, it commonly fails him when he is in search of information about particular species.

[3] Pouchet, G., *Comptes Rendus*, LXXIV., 1341–1343 (1872).

[4] Cunningham and McMunn, *Phil. Trans. Roy. Soc. Lond.*, Vol. 184B, p. 765.

[5] Camichel and Mandaul, *Comptes Rendus*, CIII., 826 (1901).

[6] Zograff, *Quar. Jour. Micr. Sci.*, XXVIII., 501 (1888).

[7] Moseley, 'Challenger Reports,' XXII., 269.

On the other hand, for the non-technical student it makes a readable account, but makes it necessary for him to search long if he desires to place his specimen. Whatever one may think of the method, President Jordan has used it with skill, and the result is an account probably as attractive as such an account can well be made. Though it does not ignore foreign fishes, it is of particular interest to Americans, since it properly gives preference to American forms. The author has given us the cream of his long experience and wide knowledge of American fishes and has made it full and attractive. There is no other account of the sort for American readers. He has wisely treated the fossil fishes in their proper sequence along with living fishes. Many systematists will not agree with President Jordan concerning the general scheme of classification adopted and in minor details, but that is unavoidable and immaterial in a book of this kind.

The book is profusely illustrated with half-tones of uniform excellence and with two striking colored plates. Ichthyologists should be especially grateful to Dr. Jordan for the admirable portraits of their colleagues, past and present. There is a valuable index, but the intentional omission of all but a very few references to the literature is to be regretted. Such selected foot-note references as are to be found in the 'Cambridge Natural History' occupy but little space and are of distinct value, even to the expert.

The publishers have given us a sightly page with large clear type and serviceable binding. The proof-reader has been sometimes at fault, though fortunately not often in the technical terms. There may be noted only 'construction' for contraction (p. 28); 'mallets' for mullets (p. 32); 'himera' for Chimera (p. 43); 'neutral' for neural (p. 56); 'ethnoid' for ethmoid (p. 113); 'Acancocephala' for Acanthocephala (p. 344). Other errors will be readily detected by the reader. In his chapter on mythology President Jordan has, apparently by the omission of a decimal point, added a new myth in making the 'sea-serpent' *Regalecus* 225 feet long (p. 361), but the measurement is correctly given in another place.

The book as a whole impresses the reader as the work of a busy man. Where the author has wandered from the narrower field of systematic ichthyology, with its attendant problems of distribution and external morphology, he has sometimes fallen into vagueness or error. Where he has depended on compilation he appears usually to have used only the more accessible and older English compendious sources and has thus helped to a longer currency some errors that others had corrected. Where, on the other hand, he has traversed his own familiar ground he has supplied a real need and supplied it admirably. In view of the great merits of his work, as he has himself said of the work of another, we may well 'pass by its faults with the leniency which we may hope that posterity may bestow on our own.'

JACOB REIGHARD.

Lectures on the Calculus of Variations. By OSKAR BOLZA. (The University of Chicago Decennial Publications, Second Series, Volume XIV.) Chicago, The University of Chicago Press. 1904. 8vo. Pp. xv + 271.

It is to be the function of the present generation of mathematical scholars in America to set a standard in mathematical memoirs and treatises which has been almost totally lacking in this country. The mathematical books which have heretofore appeared in America have been with few exceptions of text-book rank; it would be a generous estimate which would allow the fingers of both hands upon which to count books which would not be within the range of college students in undergraduate classes among the total mathematical production of the United States. There are several books in English, published in England, which are available; but the English school of mathematics has labored under such a handicap of lax reasoning and so-called 'general' statement that many of these can not be used with safety by one who is not already a master of the subject treated.

It is, therefore, a very notable occurrence when a mathematical work of really advanced

grade appears in America. Its standards of rigor, its terminologies, even its styles of typography, are destined to leave a relatively lasting influence upon future treatises of the same class. Such an influential book is Bolza's 'Lectures on the Calculus of Variations.' It will appear from what follows that this influence is to be great in many a subject besides the 'Calculus of Variations,' and that the quality of its influence is excellent in practically every particular.

The calculus of variations is one of the very first of the old (or formal) developments of the infinitesimal calculus; it is one of the newest conquests of the modern (or critical) school. The history of the older calculus of variations is almost trite from reiteration; to select among many, the works of Moigno-Lindelöf, Diegner, Todhunter, Caroll, Jordan and (more recently and more perfectly) Pascal, have made known the achievements of the old school from Newton to Jacobi to mathematicians throughout the world. The modern theory—the critical revision of the older theory—has appeared so recently that its existence is still unknown to many scientific men. Since the book under discussion is practically the first exponent of this newer work which is reasonably easy to follow, it seems fitting to state here the characteristic differences between the older theory and the new.

The essential problem may be stated here as follows: Given an integral of the form

$$I=\int_{x_0}^{x_1} f(x, y, y')\,dx,$$

where

$$y'=\frac{dy}{dx}$$

that integral will take on a fixed numerical value whenever a curve C is given by an equation of the form $y=\phi(x)$. It is proposed to find that curve C for which this numerical value is at a minimum (or maximum). The *finesse* of the whole modern theory, and the exquisite exactness of the present treatment, lies in so refining this crude statement that an accurate solution of the problem becomes possible. Thus the first question which arises is the following: Taking a supposed solution $y=\phi(x)$, are we to presume that the corresponding integral value is less than (or greater than) the integral value which corresponds to absolutely *any* other curve?—or to those which lie reasonably near to the supposed solution?—or to those which lie reasonably near and also have reasonably small difference in inclination? Are the 'comparison' curves to be reasonably continuous and have a respectable number of derivatives, or are we to admit all kinds of outlandish curves to our considerations—curves with corners—curves with no tangents—curves with no radius of curvature—curves which misbehave themselves in the variety of ways which are now known to be possible? If not, then in what sense may we say that the supposed solution really gives the integral a smaller value than any other curve near it? These questions are fundamentally important; their consideration gives to the modern theory an exactness which the older theory lacked completely; it is this attitude which renders Bolza's book a modern work.

The results of the modern theory are very satisfying in their evident accuracy, and they are none the less satisfactory in the simplicity of the conclusions reached. From a practical standpoint, it may be said that any curve which is a true solution of the problem must satisfy the very same conditions which were derived in the older books, viz., (1) the condition discovered by Euler (sometimes known as Lagrange's condition), (2) that discovered by Legendre, (3) that discovered by Jacobi. In so far there is no change, save for a greater accuracy in statement and a very material advance in the exactness of the proofs. These considerations practically exhaust the first two chapters of the book, and their presentation here can not fail to arouse lively enthusiasm in the intelligent reader on account of irresistible force of the precise reasoning and the consequent indisputable truth of the conclusions.

A curve may satisfy the preceding conditions, however, and still fail to render the integral a minimum (or maximum). This fact was discovered by Weierstrass, who succeeded

in setting up a *fourth* necessary condition. These statements apply, however, only when we admit as 'comparison curves' curves which, although they lie reasonably near the supposed solution, differ greatly from the supposed solution in inclination. For some physical applications it is evident from the nature of the problem that such comparison curves may be neglected. For example, in the famous problem of the 'Surface of Rotation of Least Resistance to a Moving Fluid,' which is due to Newton, there exist no solutions whatever in the sense just explained. That is to say, there exists no surface of revolution whatever which does not offer more resistance than some other surface of rotation, under the Newtonian assumptions regarding resistance. The possibility of such a result was entirely overlooked even within the lifetime of scientists now living, it being assumed as an *a priori* fact that some solution surely existed in this and many other similar problems. On the other hand, it is probable that any physicist would hold that the extreme *wavyness*—the krinklyness, to use a term invented by Professor Moore—which the surfaces of less resistance than the formal 'solution' must have, is really an objection to their consideration from a physicist's standpoint, in that the saw-like edges of the surface would cause a local eruption in the moving fluid which was not contemplated when the original assumptions regarding the nature and amount of the resistance were made. To meet such reasonable objection, a distinction is made between *strong* minimizing curves, *i. e.*, curves which render the integral of the problem under consideration absolutely *less* than *any* other curve *whatever* in their neighborhood, and, on the other hand, *weak* minimizing curves, *i. e.*, curves which render the integral less than any other curve which lies in the neighborhood and whose slope differs only slightly from that of the 'solution.' To clinch the point it may be stated that while there exists no solution of Newton's famous problem, there are 'weak' solutions, and these are precisely the stock solutions of the older books; the difference is that the newer theory demonstrates that there are curves which give a less resistance than the stock solution, whereas the older books would have led one to believe that such was not the case.

While this is merely a typical example, it illustrates in an essential manner the tendencies of the modern thought. The development, not of this example, but of the general theory of Weierstrass's condition and that of the *sufficient* conditions both for 'weak' and for 'strong' minimizing (or maximizing) curves forms the subject matter of the third chapter. It may be that such a precise theory is too far advanced for really practical application, but the writer is among those who believe that mechanics, physics and a few other sciences are upon the eve of the same reformation which has characterized the progress of mathematics during the past century, by which mathematics has become more really an 'exact science.' The fact that errors in conception and errors in proof have been made in that science which has been misnamed 'exact,' and that these errors have been at least partially removed through impartial and accurate investigation may be surprising to many who are not specialists in mathematics, but it would seem to suggest at the same time the possibility of similar investigation in sciences which have hitherto been classed as 'inexact,' in that it demonstrates that the difference is, after all, not so fundamental. Especially when the subject treated is as closely allied to mechanics and physics as is the calculus of variations, the possibility of rendering those subjects just as rigorously exact in certain chapters as are a few of the present branches of mathematics begins to appear less visionary. Possibly a confession in such a general scientific organ as is SCIENCE, that there are portions of mathematics—notably the theory of curves and surfaces—which are still open to fundamental criticism and objection, will tend to further the impression that there is no radical characteristic difference in exactness between mathematics and certain other sciences.

The next chapters will be of especial interest chiefly to those who are specialists in mathematics. Suffice it to say here that they treat other less specialized cases than the one

fundamental case mentioned above, and that they introduce a slightly more general form of notation, which is necessary in the last analysis for the solution of certain problems. An adequate account of these chapters can be omitted here with more grace since the writer has shown his appreciation of them in a manner more befitting their real importance in a review of a more technical character in the *Bulletin of the American Mathematical Society* (November, 1905), which will be accessible to a reader whose interest is professional.

It would be misleading to leave an impression that Bolza's book is elementary or that it can be read without special mathematical training. It is highly technical even in comparison with most of the extant *English* works on mathematics. Its standards are not higher than they should be, however; they are unusual in a book printed in English; they are not higher than the average standard of the classical foreign mathematical treatises; they *are* beyond question a step in the right direction.

This book is not primarily a text-book; it will not share the speedy oblivion of that class; and there are many evidences that this and a few other extremely recent mathematical books published in America are merely the first of a considerable volume of mathematical productions of like grade, which, if the average standards remain equal to those set by this book, will indeed deserve to be called an American mathematical literature.

E. R. Hedrick.

Columbia, Mo.,
December 1, 1905.

SOCIETIES AND ACADEMIES.

THE WASHINGTON ACADEMY OF SCIENCES.

At a meeting of the academy on November 28, Professor Wilhelm Ostwald, of Leipzig, who is now lecturing at Harvard University, gave an interesting address upon the proposed 'Universal Auxiliary Language.' The substance of his address was as follows:

In our time, when international congresses of all kinds, scientific, commercial, political, etc., are gathering almost every day, the necessity of a general means of mutual understanding is felt more keenly than at any former time. Small wonder therefore, that at one of these congresses, that of philosophy, held at Paris, 1900, the question was earnestly discussed, whether it was possible to overcome this insufferable obstacle to the common work of mankind. As a result, an international committee was elected to consider the matter and to propagate the general idea. This committee came to the conclusion that the selection or creation of a general auxiliary language was necessary, which should not supplant the existing languages, but should be learned by everybody besides his native speech for the purpose of international intercourse. This language must satisfy the following three conditions:

1. It must fulfill the needs of ordinary intercourse of social life, of commercial communications and of scientific and philosophic relations.

2. It must be easily acquired by every person of average elementary education, and especially by persons of European (and American) civilization.

3. It must not be one of the national languages.

Upon this program a widespread and effective propaganda has been developed. About 800 scientists of various countries, all university professors or members of scientific academies, and besides these about 200 societies of the most various kinds: scientific societies, chambers of commerce, touring clubs, etc., representing many thousand members, have joined the general movement. The purpose is, to ask after due time the Association des Academies, which represents the most important academies all over the world and is, therefore, the highest scientific corporation existing in our days, to take over this work of the international auxiliary language as its own, to appoint a working committee for the selection and introduction of such a language and to form a lasting and effective center for its culture and development. In case the association should decline this noble and important task, such a working committee will be selected by the above named international committee, formed by the representatives of

the different societies, etc., which have joined the movement.

Of the three conditions, the first two are self-explaining; only the third needs some discussion. The reason that any national language is considered as to be excluded is twofold. First, because the nationality whose language is chosen would obtain thereby an undue and unjust advantage over all other nations; it can not, therefore, be hoped that any such language will ever become truly international. The other reason is, that every natural or national language is sadly imperfect as compared with the possible ideal of a normal or regular language. The purpose of every language is to give a twofold coordination: one between ideas and sounds, and another between sounds and letters; by this means we can tell and write our ideas and can hear and read the ideas of our fellow men. To make such a coordination effective and consistent, it should be *univocal;* this means, that every idea should be coordinated only to one word, and *vice versa,* and that every sound should be coordinated only to one letter and *vice versa* again. Besides this, the coordination should be as simple as possible.

Of the natural languages none fulfils any of these conditions. Even if we abstract from the coordination between ideas and sounds (or written words) and consider only the coordination between letters and sounds, we never find it univocal. Italian and German are rather near to the ideal, because here the scripture is phonetic, but not yet fully so, while English is known as the worst possible language from this point of view. On the other side, Italian and German are very imperfect as to simplicity; they keep still the entirely useless differences of gender and express the same idea several times in the same sentence, for example, in coordinating to the plural in the subject superfluous plural forms in the adjective, the verb, the article and so on. English has made itself free from most of these superfluities, using only one article and almost no coordinations between the different members of a sentence. But there are still superfluous forms enough; the most frequent English phrase: 'how do you do?' giving a striking example.

If there is no natural language, which fulfils the claim of simplicity and regularity, the question arises, if an artificial language may be constructed according to these conditions. Generally this question will be answered in the negative, but only on so-called theoretical reasons. To do-away at once with probabilities, we will consider only facts. There exists an artificial language, called 'Esperanto' which is spoken and written by almost half a million people, which has about fifty periodicals and a stately collection of other books. A few months ago the Esperantists held their first international meeting at Boulogne, France, where 1,200 persons of twenty different nationalities were assembled, to try if it was possible to understand one another only on the basis of a language learned from books without oral teaching. This first experiment was in every way a grand success. There was not the slightest difficulty in understanding one another; even the English Esperantists pronounced the vowels quite clearly, in spite of their use or misuse in their own language. A play was performed, in which each player was from a different nationality and had learned his part at home, so that they met for the first time on the stage; the play went on without any difficulty for the players or the audience. Indeed, every possible application of a language was tried on this occasion, and all succeeded perfectly.

Space will not permit me to give a closer description of this language; every one, who desires to learn somewhat more about it, is kindly invited to apply to The Esperanto Club of Harvard University, Cambridge, Mass. By the same way information may be obtained as to the Delegation for the Adoption of an Auxiliary International Language, and its work.

Only one question can be answered at this place: will Esperanto be adopted by the delegation? It is impossible at present to say. Personally, I am inclined to believe that, indeed, Esperanto, either unchanged or after some slight modification, will be the auxiliary language of the future, but this is only a

personal judgment. Whatever language is chosen, it will be in any case the most important step mankind has taken since the invention of printing, for its future unification and for the saving of an enormous amount of hitherto wasted energy.

In the discussion which followed Professor Maurice Bloomfield, of the Johns Hopkins University, pointed out that the history of the second half of the nineteenth century in Europe was largely a history of re-nationalization. United Italy and Germany, Hungary and Bohemia are cases in point. Every minute and subjected people in southwestern Europe is engaged in furbishing up anew its national character. Each of them insists upon its own language as the chief sign of its individuality. Under these circumstances the hope that any one of the existing languages may become universal vanishes into thin air. The possibility of an artificial universal language comes to the fore, and the experiment deserves the most cordial support of all enlightened men. Nevertheless, Professor Bloomfield could not refrain from pointing out how much there is in language of organic growth, of mixed expression, which can not be produced artificially—chains of related and mixed words like 'hurry,' 'flurry,' 'scurry,' like

hurry bustle
hustle rush
rustle

showing some of the mixed expressions which arise in speech through the subconscious creation of the individual and through the subconscious adoption of that creation by the masses. Simple idiomatic expressions like 'three years ago'—'Il y a trois ans,' 'vor drei Jahren'—illustrate how difficult it is to find common ground for even the most commonplace expression. Continuous issue of new words from a bureau of fabrication would exercise an incessant strain upon even the most willing disciples of an artificial language.

Professor Bloomfield was followed by Professor Mitchell Carroll, of the George Washington University, who spoke briefly in favor of Esperanto.

THE BIOLOGICAL SOCIETY OF WASHINGTON.

THE 405th regular meeting of the Biological Society was held on November 11, 1905, with Vice-President Hay in the chair and 36 persons present. Under brief notes and exhibition of specimens, Dr. B. W. Evermann said that while collecting yellow fever mosquitoes in Santo Domingo, Mr. August Busck had incidentally collected six specimens of fish, including four species, three of which proved to be new. Mr. W. H. Osgood exhibited an almost perfect molar tooth of a mastodon from Dawson, Yukon Territory, Canada. He stated that while mastodon remains had been found over a great part of the United States, the northernmost record up to the present time had been from near Lake Winnipeg, Manitoba. The tooth had been compared with specimens in the National Museum and found to agree with those of typical mastodons. Mr. W. L. Hahn showed a photograph of a red maple branch that had taken root in the ground and proceeded to grow. He also reported a specimen of the little brown bat, *Myotis lucifugus*, in the U. S. National Museum collection from Kamchatka, the previously most western record being from Kadiak Island, Alaska. The specimen was collected by Dr. W. H. Dall and proves to be typical *lucifugus*. Dr. C. W. Stiles reported that he had recently had sent to him for determination specimens of rat-tailed larvæ (*Aristilia*) alleged to have been passed by human patients. A case of pseudoparasitism of this form is reported by Brera in 1809, and Dr. Stiles has recently examined specimens from two or three such cases in the United States. These specimens were also examined by Dr. L. O. Howard. Dr. Theodore Gill spoke of the wolf fishes of the genus *Anarrhichas*, of their distribution in the Atlantic and of their relationship. He finds that the species *donticalatis* and *latifrons* are generically distinct from the rest of the group. Mr. Walter H. Evans spoke of the introduction of minnows into the tero and rice ponds of Honolulu for the purpose of destroying the larvæ of the yellow fever mosquitoes. Dr. B. W. Evermann added that between 450 and 500 of these minnows, *Fundulus* and *Mollienesia*, transferred by Mr. Seale from Galveston,

Texas, to Honolulu were doing well and increasing rapidly. When liberated they immediately began devouring the mosquito larvæ. The *Mollienesia* are viviparous and soon after they were released many young were born. At the latest report the minnows numbered about 2,000.

The first regular paper of the evening was by Dr. E. L. Greene on 'Linnæus as an Evolutionist.' In the 'Philosophia Botanica' it was shown that Linnæus had clearly expressed his views that species were the same as when created in the beginning and as they were to remain for all time. In the later 'Species Plantarum' Dr. Greene was interested to find a query as to whether a certain species were not derived from another related species, and on reading through the 1,600 pages of this work he found numerous queries as to whether one species of plant had not been derived from some other species or acquired certain characters by adaptation to environment—soil or climatic conditions. Thus while in one place expressing an orthodox belief in special creation, his later querying is that of an advanced and pronounced evolutionist.

The second paper on the program was by Mr. Frederick V. Coville, on 'The International Botanical Congress at Vienna.' He said this was one of a series held every five years. It was attended by about 500 delegates, from the United States and most European countries, of which the German-Austrian group was greatly in the majority. The morning sessions of the meetings were devoted to presentation of botanical papers, the afternoon sessions to the adoption of a code of botanical nomenclature. The main questions brought up were: (1) The rejection of the Kew rule by adopting the principle of retaining the oldest specific name in whatever genus published; (2) an exception to the retention of the oldest specific name was made when it was identical with the name of the genus; (3) the American principle of rejecting homonyms was not adopted; (4) the principle of fixing upon a single species as the type of a genus was not accepted; (5) the principle of binomialism as a requisite for the publication of a genus was not adopted; (6) it was voted that after January 1, 1908, new names should not be valid unless accompanied by Latin diagnoses. Unfortunately, no preliminary meetings of the committee had been held for discussion and perfection of the code, and the proposals of the Americans to refer to committees points to which there was a large opposition was rejected.

Dr. Stiles discussed several points in connection with Mr. Coville's paper. He explained the organization of the international commission on zoological nomenclature and expressed the opinion that such organization was superior to the plan followed by the botanists, as the zoological plan not only provides for any necessary changes, but guards against any radical and unnecessary changes in nomenclatural customs. He thought that when zoological and botanical nomenclature were declared as independent of each other a very unfortunate mistake was committed, since such a rule was made without consideration of the numerous difficulties it would make for men working in the protozoa. However, now that the rule was generally adopted it was not feasible to attempt to rescind the rule. The zoological code provided, however, for certain cases which arise. He was of the opinion that the botanical provision that all new descriptions should be written in Latin was an unfortunate one and not capable of general practical application. He maintained that any man is able to write his own mother tongue more clearly and more concisely than he is able to express himself in a foreign language; further, probably not fifty per cent. of the men actively engaged in zoological and botanical work are able to read Latin with ease and certainly a smaller per cent. are able to write Latin. The rule in question as adopted by the botanists seemed to him not only a step backwards but further it played into a rather important local question in educational matters in certain countries and the rule would doubtless be cited by scientists in those countries in support of certain questions and legislation which were of purely local interest to those countries. It would further result in decreasing the activity of a number

of men in scientific work in case an attempt were made to enforce the rule. He believed, however, that the rule would be ignored by the majority of workers. Regarding the principle of tautonomy, he expressed himself not only as not opposed to it but as highly in favor of it, and he himself has decided to purposely introduce tautonimic names whenever the occasion presents itself. By use of tautonomy, the type species of a genus is shown in its name; without tautonomy, it is necessary to refer to the literature in order to recall the type species.

He did not believe it possible to enforce the rule concerning the list of excepted names. In fact, this rule did not seem to mean very much to him, as the congress had failed to determine the types for the names which were excepted and had apparently failed to provide for cases in which the genera in question might be defined in the future.

He recognized the delicacy of the situation which now faces the American botanists, but it seemed to him that the botanical code contained so many subjective elements that it was impossible for this code to expect to have a very long life. It has been the history of nomenclature since the time of Linnaeus that rules based on subjective ideas were short-lived. A rule in nomenclature must be objective if we expect it to be accepted generally and if we expect it to be permanent. Discussion followed by Dr. Gill.

The last paper on the program was by Dr. Hugh M. Smith on the 'Sargassum Fish,' a tropical species of the southern Atlantic occasionally brought by winds and currents to more northern shores. A large number of the fish were taken at Woods Holl and vicinity. The eggs from these prove to be entirely different from those described by Agassiz and long supposed to have belonged to the sargassum fish. Specimens of the fish were shown and a beautiful painting of it by C. R. Knight, showing its wonderful protective coloration. The paper was discussed by Dr. Gill.

Vernon Bailey,
Recording Secretary, pro tem.

DISCUSSION AND CORRESPONDENCE.

ONTOGENETIC SPECIES AND OTHER SPECIES.

Referring to the admirable article in Science (November 24, 1905, p. 661) on 'The Evolution of Species through Climatic Conditions,' by Dr. J. A. Allen, I may once more gratefully recognize my own especial indebtedness to Dr. Allen's pioneer investigations of thirty years ago in this particular direction. These studies have been epoch-making in the history of ornithology.

It remains, however, to be determined whether these environmental forms—these species and subspecies produced by the direct influence of heat, cold, humidity and aridity —are 'ontogenetic species' (a term originating, so far as I know, with Professor V. L. Kellogg) or whether they have a real existence outside the lifetime of the individuals actually composing the group or species. We do not know which of the traits induced by direct section of the environment, if any, are actually hereditary and which are not. If we find that the dusky woodpeckers of Vancouver Island retain this shade when reared in Arizona, then humidity would be a real factor in the formation of species. If such birds, transferred in the egg to a new region should develop in the fashion of the local race of this region, and not like their own parents, then the duskiness is not a true specific or subspecific character. The real character of the species would be found in the tendency to develop dark plumage in humid surroundings and pale feathers under other conditions. In such case humidity would be merely a factor modifying individual development but not connected with the origin of species.

It may be that these questions have been already solved by experiment on birds, but if so, the experiments have escaped my attention. Eggs of the woodpeckers, chickadees and other birds showing dusky phases should be hatched in the arid plains. The red-shafted flicker of California should be bred in New England, and the permanence of the difference between large birds of northern range and their smaller southern homologues should be tested.

An 'ontogenetic species' its traits produced by the direct action of the environment, is the Loch Leven trout (*'Salmo levenensis'*), which I have lately discussed in these columns. Transferred to the brooks of England or to those of California, this supposed species loses its lake-bred characters and becomes the common brook trout.

Perhaps our ornithologists will some day test their species and subspecies by a test of the permanence of this class of characters. No doubt we should drop from the systematic lists all forms which may prove to be purely ontogenetic, all whose traits are not fixed in heredity.

In my recent article, as noticed by Dr. Allen, I have used the word 'barrier' a little too vaguely. For the purposes of this study, I should regard a broad plain as a barrier to a species which inhabits it, even though it were abundant, from one side to the other. A barrier in this sense is anything whatever which checks free interbreeding, even though it offers no actual check to the life or movement of the species. With quiescent animals, the individual moves but a short distance and the traits at one end of an unbroken series may be quite different from those of other individuals at the farther end, as Dr. Allen has very properly suggested. The term 'bionomic barrier,' used by Dr. A. E. Ortmann in a personal letter, seems to me a very apt one as covering the species-producing phases of isolation.

Certain papers of Rev. John T. Gulick on the evolution of species of land-snails and other animals deserve more attention than they have received. In one of these papers, 'Divergent Evolution through Cumulative Segregation' (Smithsonian Report for 1891, p. 273), Mr. Gulick corrects certain erroneous assumptions on the part of Dr. Moritz Wagner. Mr. Gulick says:

> Separate generation is a necessary condition for divergent evolution but not for the transformation of all the survivors of a species in one way.
>
> Separation does not necessarily imply any external barriers or even the occupation of separate districts.
>
> Diversity of natural selection is not necessary to diversity of evolution.
>
> Difference of external conditions is not necessary to diversity of evolution.
>
> Separation and variation—that is, variation not overwhelmed by crossing—is all that is necessary to secure divergence of type in the descendants of one stock, though external conditions remain the same and though the separation is other than geological. The separation I speak of is anything in the species or the environment that divides the species into two or more sections that do not freely intercross, whether the different sections remain in the original home or enter new and dissimilar environments.

All of this is in general accord with my own experience.

DAVID STARR JORDAN.

ORTHOGENETIC VARIATION?

IN a recent paper[1] I reviewed Gadow's hypothesis of 'Orthogenetic Variation,'[2] in the light of his own evidence, and in the light of such observations as could be added. In SCIENCE for November 7, 1905, Dr. Gadow publishes a reply under the title 'Orthogenetic Variation.' It would be superfluous merely to rediscuss the data previously published; in fact, had the matter gone no further than the original paper, elaborate criticism in the first instance might have been unnecessary, since scientific readers could judge the evidence for themselves. But unfortunately, as will be shown below, subsequent use has been made of the idea for presentation to the general public, not expressly as a tentative hypothesis—but *without qualification*.

In the first paragraph of his reply, Gadow says, 'I am anxious that it [orthogenetic variation] should not be misrepresented,' and, in the second paragraph, 'the paper by Mr. Robert E. Coker * * * calls for some remarks on my part by way of protest and correction.' I was glad that after careful reading of his paper, I found no reference to any statement

[1] Gadow's hypothesis of 'Orthogenetic Variation in the shells of Chelonia,' Johns Hopkins University Circular, No. 178, May, 1905.

[2] 'Zoological Results Based on Material from New Britain, New Guinea, Loyalty Islands and elsewhere, collected during the years 1895, 1896 and 1897, by Arthur Willey,' Part III., pp. 207–222, Pl. XXIV., XXV., Camb. Univ. Press, May, 1899.

of mine that had 'misrepresented' his hypothesis, and so needed 'correction.' In fact, I did not suppose I could have misrepresented it, because I had given it merely by quoting his own words at length. Two of the paragraphs quoted by me Gadow quotes in his recent paper, following them with the words "I think I had stated the case fairly. It left no doubt about the definition of at least one kind of orthogenetic variation" (p. 638). But we are indebted to his recent paper for the very concise statement that 'cases of orthogenetic variation are simply ontogenetic stages, passing reminiscences of earlier phylogenetic conditions.' The basis for his assumption that the abnormalities in number and arrangement of the horny shields of turtles are 'orthogentic variations' is a table of percentages of abnormalities, made from 76 specimens (47 new-born, and 29 of various sizes, from three inches to 'large'). This series of percentages of abnormalities, the percentage decreasing with age, is supposed to indicate that turtles 'amend their scutes' and 'grow out of these irregularities by the reduction or squeezing out of certain scutes.'

Gadow states (p. 639) that with the addition of my embryos to his 76 specimens, 'the percentage still decreases with age'; and gives the following revised table, including both sets of turtles:

	Per Cent.
Of 73[3] embryos or newborn, 53 are abnormal..	7[4]
Of 9 specimens from 3 to 8 inches, 3 are abnormal	33
Of 19 specimens from 8 to 24 inches, 5 are abnormal	22[5]
Of 9 specimens from 24 inches to 'large,' 2 are abnormal	24[6]
Of 7 large specimens, only 1 abnormal	12[7]

The table requires a comment. The last four groups are based, not on (9+19+9+7) 44 specimens, but on only 29, for 15 turtles were counted twice: the six 8-inch specimens in both second and third groups; the two 24-inch specimens in both third and fourth groups; and the seven 'large' specimens in both fourth and fifth groups. *Twenty-nine specimens divided into four groups, from which a series of per cents. is computed* to be compared with a per cent. based on a comparatively few newborn turtles—and this the *sole basis for an elaborate hypothesis*, given to the scientific world with the supporting (?) evidence and, subsequently, *given to the general public,* without the evidence, in a comprehensive monograph on 'Amphibia and Reptiles.' This I regard as the 'sole basis,' for though his comparison of the abnormalities with supposed phylogenetic stages is interesting and suggestive, and may support an interpretation of the abnormalities as *atavisms,* it does not in the least imply that *the individual recapitulates these stages,* and if the latter assumption has other basis than the table of percentages, what is it?

The writer is now pursuing anatomical and embryological studies, the results of which may have some bearing on the interpretation of the abnormalities in question, and these results will be given out in due time. But the question at present is not—Can Gadow's assumption be disproved? but—Have there been in hand facts to justify its promulgation? Being promulgated, should it be included *without qualification* in a comprehensive monograph intended for the general public, who will not refer to the original paper to find that it is merely a hypothetical assumption from a very small number of facts? The reference is to the 'Cambridge Natural History,' Vol. VIII., 'Amphibia and Reptiles,' by Hans Gadow (London, 1901), where the following unqualified statements occur (the italics are mine):

It is absolutely certain that the number of transverse rows also was originally much greater than it is now. The mode of reduction of the numbers of the neural and costal shields has been studied in *Thalassochelys caretta* (cf. p. 388.) The accompanying illustration (Fig. 68) [This is a reproduction of text figure, from Willey's Zoological Results. R. E. C.] shows *some of the many stages actually observed* in the reduction of the

[3] Presumably typographical error. Gadow's 47 newborn plus my 28 embryos = 75.

[4] Presumably typographical error. 70 intended.

[5] Presumably typographical error. 26 intended.

[6] Presumably typographical error. 22 intended.

[7] Presumably typographical error. 14 intended.

shields. The chief point is that *certain shields are squeezed out, or suppressed by their enlarging neighbors.* The ultimate result is the formation of fewer but larger shields.[8]

Can these words be intended figuratively, the reference being to phylogenetic development, not to 'orthogenetic variation,' with all that that term, as defined by Gadow, implies? If so, the cross reference on a later page is certainly misleading: for in his discussion of the variations of *Thalassochelys caretta,* he says:

The interesting fact in connection with these variations is, moreover, that some of the shields are much smaller than the others, sometimes *mere vestiges in all stages of gradual suppression,* and that the *abnormalities are much more common in babies and small specimens than in adults. The importance of these 'orthogenetic variations' has been discussed on p. 326.*[9]

ROBERT E. COKER.

JOHNS HOPKINS UNIVERSITY,
November 28, 1905.

ON THE GRANTING OF THE M.D. DEGREE.

A SHORT time ago I received a letter from a member of a state board of medical examiners which touches upon a matter of present interest.

The letter, from which I shall quote, was in reply to one giving information respecting courses in this college designed for students who have the study of medicine in view.

After remarking that in his state the medical examiners had decided to give one year's credit to graduates of colleges, provided certain subjects in biology, chemistry and physics had been pursued in the college course, he proceeds as follows:

The fact is that many of the colleges teach these branches better than the average medical school. Any ordinary high school boy can enter the medical department of the university. Yet, they are not willing to give a year's credit to men who take four years beyond their entrance requirement. The confederation of state medical boards is divided on the question. So long as the average medical school admits high school graduates, I shall stand for giving one year's time to men who take a college course. Or, in other words, seven years for the combined medical and college course. Not six years as proposed by Michigan, provided men take both courses at Ann Arbor. The seven years seem to me to be only fair play as an encouragement to the higher education.

What I wish to write you about in particular, is this: The present regulation is not to give the college men any time credit. The plan originates with medical schools in universities where they have also an arts department. They do allow the medical and college course to be completed in six years instead of eight, but it requires men to go to their college department. Now there are several medical schools requiring a straight B.S. or A.B. degree for entrance, such as Johns Hopkins, Harvard, and Rush in 1907. If men going from colleges * * * will all go to schools requiring the A.B. or B.S. entrance requirement, it will do more to help us to bring the medical schools into line than anything I know of at present. It seems to me the professors in these colleges should bring every pressure to bear on their prospective medical students to get them to go to the medical schools only that require degrees for entrance.

Upon the question of requiring either the B.A. or the B.S. degree as a preliminary to a medical course it is not my purpose to speak further than to say that I do not think the time has come in this country to make such requirement, unless upon the completion of such course the degree M.D. is to be given.

President Hadley has this to say on the general subject of requirements for admission to the professional schools of Yale:

However convenient it might be to insist on the possession of a bachelor's degree by all pupils in the schools of law or medicine, I feel that it would be a violation of our duty to these professions to hedge ourselves about by any such artificial limitations. We should make the standard of admission to our law and medical schools higher than it is at present; but we should base it upon qualifications for professional study which we could test by an examination, rather than upon previous residence at an institution entitled to give a bachelor's degree. If a man is really fit to study law or medicine we should encourage him to study law or medicine with us, without making arbitrary restrictions.

No one will be likely to question the wisdom of President Hadley's remarks, provided the

[8] *Loc. cit.*, p. 326.

[9] *Loc. cit.*, p. 388.

degree to be given at the end of the course in law or medicine is the bachelor's degree.

If, however, the doctor's degree is to be given at the end of the course in law or medicine, then an entirely reasonable prerequisite, a prerequisite which is justified by the generally approved custom in the case of the Ph.D. degree, would be to require the possession of a bachelor's degree.

Certain of the smaller colleges that still occasionally give the degree of Ph.D., without requiring residence study, have had the enormity of their educational transgressions pointed out to them by those interested in university work.

Of course, the practise of giving the Ph.D. degree as an honorary degree is not to be defended and would receive no encouragement if the conferring of the degree were referred to the teaching force of our colleges, instead of being kept as a prerogative of boards of trustees.

But there are other offenders against good taste in the matter of conferring degrees beside the small colleges; and one is tempted to remark that the practise of certain universities of offering as inducements to students to come to them, the opportunity of shortening their combined undergraduate and professional course, smacks somewhat of the bargain counter.

Any institution which makes such offer of course pays the price for any advantage which it may gain in increased attendance, in the lower place which it thereby takes in the estimation of a critical public as compared with institutions which do not resort to such devices to lure students to their halls.

The one point, however, which I wish to emphasize in the present communication is this: The doctor's degree should be a second degree and should not be given, unless as an honorary title, to any one who has not earned a bachelor's degree.

This proposition will not be dissented from by any university when the degree of Ph.D. is in question. Why should there be any hesitation then in requiring a bachelor's degree as a prerequisite to the M.D. degree?

At many universities two boys, presenting themselves with the same preparation, may enter on the same date; the one registering in the undergraduate department, the other in the medical school. At the end of four years the one receives the bachelor's degree, the other the doctor's degree. Such anomalous conditions can not be justified on educational grounds.

It follows that the doctor's degree from a school of medicine which does not make the possession of a bachelor's degree an entrance requirement is, judged by educational standards, on a par with the bachelor's degree. Graduates of such schools, therefore, should be given the degree of bachelor of medicine instead of doctor of medicine.

I am not arguing that a bachelor's degree in arts or science should be required of every one who proposes to practise medicine. I am not discussing the question of the desirability of having the practitioner a broadly educated man. Neither do I propose to discuss the claims made in behalf of certain medical schools that they turn out better trained practitioners without requiring a bachelor's degree for entrance than is done by schools which require a bachelor's degree for entrance. Claims of this sort are easily made. The discriminating public will judge the institution by what the graduates prove to be rather than by what they are said to be.

While I do not think we are ready in this country to say that no one should be permitted to practise medicine until he has gained the degree of M.D., we may and should insist that he be a graduate of a reputable medical school, and that he pass successfully the examination set by the state board of medical examiners.

It is, perhaps, not too late to insist that the degree M.D. be put on a par with the degree Ph.D., instead of ranking, as it does now, except as it comes from a very small number of medical schools, with the bachelor's degree.

EDWIN LINTON.
WASHINGTON AND JEFFERSON COLLEGE,
October 13, 1905.

THE PROPOSED BIOLOGICAL STATION IN GREENLAND.

TO THE EDITOR OF SCIENCE: It was my pleasure some time ago to communicate to the readers of SCIENCE that the money for the erection of a biological station in Greenland is donated by a citizen of Denmark. I am now able to add further that it is donated by Herrn Justitsraad P. Holck, of Copenhagen. He has donated 35,000 Kroner (about $10,000) for that purpose, which is the estimated cost, according to Magister M. P. Porsild's plan. It now remains for the Danish government only to appropriate money enough for its running expenses, which, according to Mr. Porsild's plan, will amount to 11,000 Kroner (about $3,000) a year.

To show the great interest which scientists have taken in Magister Porsild's plan I could mention the numerous articles in Danish, Swedish, German and American scientific journals, and the recommendations from leading biologists and polar explorers, as Professor Fridthof Nansen, Sir Clements Markham, Professors Vanhöffen, von Drygalski, Aug. Warming, K. V. Steenstrup and F. Jungersen, Drs. Gunnar Anderson and Georg Brandes, and many others. In the United States it has been highly recommended by Professors E. B. Wilson, C. O. Whitman, J. Loeb, T. H. Morgan and Mr. Pehr Olsson-Seffer, Ph.D.

Sir Clements R. Markham, president of the Royal Geographical Society in London, says: "Your proposal to establish a biological observatory is, in my opinion, deserving of support. I believe that the science of geography would be advanced by it, and would derive important results. * * * I wish you all possible success in your efforts to secure that result ever."

Professor Dr. Vanhöffen, in Petermann's *Geogr. Mittheilungen,* says: "A kind of biological station was established in Greenland in the time of Holbölls and Rinks, the former remained there eighteen years, the latter twenty years. They were the central figures in the exploration and investigation of Greenland. Especially Mr. Rinks knew the people of Greenland well and we have as a result his classical work, 'Grönland, geografisch und statistisch beschrieben.'" After a longer description of Mr. Porsild's plan, he states: "It is a very extensive plan that the leader of the future arctic biological station has; but, without doubt, great results are to be expected from such a station."

The north polar explorer Professor Fridthoff Nansen says: "A biological station in Greenland will be of immense value for scientific research. Especially the investigation of its fauna and flora can not help to give results of utmost importance to biological science."

As soon as the Danish government has decided to appropriate money for the support of the station I shall publish an article and describe the proposed function and the opportunities offered to investigators in the first arctic biological station.

At present we can only express our sincerest thanks, high respect and gratitude to men of science in foreign countries who have shown their interest in this Danish scientific undertaking, which we hope will add greatly to the universal advance of biological, geological and geographical science.

M. E. HENRIKSEN.

COLUMBIA UNIVERSITY,
December 1, 1905.

SPECIAL ARTICLES.

THE ASSUMED PURITY OF THE GERM CELLS IN MENDELIAN RESULTS.

CUÉNOT has recently published[1] in the fourth note of his important series of experiments with mice, certain results with yellow mice that are of fundamental importance as bearing on the question of the assumed Mendelian purity of the germ-cells. His results and his interpretation of them are briefly as follows:

Wishing to obtain 'pure' yellow mice, he crossed yellow mice known to be heterozygotes (*i. e.,* containing recessive gray or black in this case). According to the Mendelian formula he should have obtained the following results:

$$CYCG \times CYCG = 1\,\underset{\text{Yellow}}{CYCY} + 2\,\underset{\text{Yellow}}{CYCG} + 1\,\underset{\text{Gray}}{CGCG}.$$

[1] 'Les Race Pures et Leur Combinaisons chez les Souris,' *Arch. de Zool. Exp. et Gen.,* 1905, Vol. III., Notes et Revue, page cxxiii.

The letter C in this formula stands for any color (in contrast to white, $A =$ albinism); G indicates gray, and Y yellow-bearing gametes. The formula shows that 25 per cent. should be pure yellow, 50 per cent. yellow-grays (*i. e.*, dominant recessives), and 25 pure grays. To his surprise he got no pure yellow mice, CY, but only impure yellows (*i. e.*, yellow dominants, $CYCG$). Quantitatively there were 72.7 per cent. yellows, $CYCG$, and 27.3 per cent. 'pure' grays.

Why were no pure yellows obtained? In other combinations yellow seemed to follow the same rule as the other colors, gray, black or brown, but neither the pure yellow CY, nor the albino with yellow alone recessive, AY, nor the yellow heterozygote $CYAY$ could be obtained.

Cuénot explains these curious results by means of the assumption that the gametes (eggs or sperm) having the formula CY or AY never unite to give the forms $CYCY$, $AYAY$, $CYAY$. In other words, yellow-bearing spermatozoa never unite with eggs bearing the yellow color alone. If this conclusion could be established with certainty it would have a fundamental bearing on all questions connected with Mendelian phenomena. It is, therefore, of the utmost importance to know whether Cuénot's interpretation is the only one that can be given to his results.

It seems to me, in the first place, highly improbable that such a trivial difference as the color of the hair could absolutely prevent the conjugation of the gametes carrying these colors, especially when we recall that the same gametes must carry thousands of other unit-characters that are identical.

It seems also more *probable* that the results mean, that the color, yellow, was never disassociated from one of the other colors, gray, or black, or brown; and that the results are due to this and not to the disjunction of yellow and its failure to combine with yellow again. On this basis, moreover, all the facts can be explained according to the Mendelian formula. Incidentally the whole question of what is meant by the '*purity*' of the germ cells is here raised. Let me now try to show how these claims can be justified.

Cuénot obtained his yellow mice by crossing an albino of unknown ancestry with colored mice. His yellow mice must, therefore, have contained gray (or black). Now the theory of 'pure' germ-cells *assumes*, in order to explain the Mendelian ratio, that the germ-cells of $CYCG$ separate into two sorts, CY and CG. I *assume*, on the contrary, that the mixed characters do not separate again, but alternately dominate and remain latent giving $CY(CG)$ and $(CY)CG$. Two mice of this kind paired will give:

$$\begin{array}{ccc} & CY(CG) \quad (CY)CG & \\ & CY(CG) \quad (CY)CG & \\ 1\,CY(CG) & +\,2\,CY(CG)\ (CY)CG & +\,1\ (CY)CG. \\ \text{Yellow} & \text{Yellow} & \text{Gray} \end{array}$$

Thus there will be three yellows to one gray. There are, moreover, two classes of yellows, but while the first group $CY(CG)$ will breed true, the other group $CY(CG)(CY)CG$ will split in each successive generation according to the Mendelian formula. There is an implication in this point of view of importance for the conception of germ-purity. The gray in the latent condition in $CY(CG)$ is different from the gray in the recessive condition in $CY(CG)(CY)CG$, for the former remains in the latent condition to CY in inbreeding, while the latter, the free CG, becomes dominant in half of the germ cells. Thus the germ cells of $CY(CG)$ are all $CY(CG)$, but half the germ cells of $CY(CG)(CY)CG$ are yellow, $CY(CG)$, and half gray, $(CY)CG$. The same rule applies to the 'pure' grays $(CY)CG$ in which the latent (CY) always remains latent in inbreeding. Crossing with other races may, however, bring the yellow from its latent position to dominance or to recessiveness again.

Cuénot's yellow mice were, on my view, either $CY(CG)$ or $CY(CG)(CY)CG$. The former if inbred should give usually yellow mice, but if crossed with mice of other colors, or united with $CY(CG)(CY)CG$, would give some grays. Cuénot's somewhat ambiguous statement on the top of page cxxix may accord with this view, although it may have a different meaning. He obtained no pure yellows, $CYCY$, because, on my view, his yellow mice were contaminated at the start.

The result is exactly the same as when a so-called 'pure' Mendelian gray mouse is obtained through a cross. The 'pure' dominant is contaminated in the same sense as the 'pure' recessive and in the same way. For example, a gray mouse crossed with a black will give a mouse $CGCB$ whose germ cells will be, on my view, $CG(CB)$ and $(CG)CB$. Such mice inbred will give

$$1\,CG(CB) + 2\,CG(CB)\ (CG)CB + 1\ (CG)CB.$$

The so-called 'pure' dominant, $CG(CB)$, is really only a dominant gray with black in the latent condition. This form is strictly comparable to the yellow mice that Cuénot tested for purity, and could not be expected to give by inbreeding a form with perfectly pure germ cells, $CGCG$. To obtain such a pure gray mouse, $CGCG$, a wild form, never crossed with black, must be sought; for, once crossed always contaminated.

The preceding results given for these special cases are strictly in accordance with what is now becoming recognized in regard to the usual condition of albino mice. It has been shown that these carry gray, or black, or some other color *latent*. Thus a white mouse is $A(G)$ or $A(B)$ or $A(Y)$. Suppose one of these white mice, with the formula $A(G)$, is crossed with a pure gray mouse, with the formula CG:

$$A(G) \times CG = A(G)CG.$$

The offspring are all gray, because free gray dominates free white. Suppose now we inbreed these $A(G)CG$ mice. Their germ cells will be, on my point of view, of two sorts, viz., $A(G)(CG)$ and $(A(G))CG$. The resulting offspring give

$$\underset{\text{White}}{1\,A(G)\,(CG)} + \underset{\text{Gray}}{2\,A(G)\,(CG)\,(A(G))\,CG} + \underset{\text{Gray}}{1\ (A(G))\,CG.}$$

Since albino is white, while C stands for the color with which it is associated, we may simplify the form of the equation by omitting the C's and putting the G's together, thus:

$$1\,A(G) + 2\,A(G)\,(A(G))\,G + 1(A(G))\,G.$$

Thus our formula gives the Mendelian results, but it also brings to light the different relation of latent (G) and free G. If individuals of the middle group above be inbred, they again give the Mendelian ratio 1:2:1; because the free A and the free G alternately dominate and become latent, so that the germ cells are $A(G)$ and $(A)G$.

It is needless to go over the well-known Mendelian combinations of other sorts, back crossing, etc., since they also work out according to our formula.

The important point is not that there is offered here a new set of Mendelian formulæ, but a new conception regarding dominance and recessiveness, which I believe to be better in accord with the conditions found to exist in extracted recessives. Furthermore, this idea brings into question the assumption of the so-called purity of the germ cells, by means of which modern writers are explaining the Mendelian results. Purity only means dominance over latency. Dominance over recessiveness follows a different rule, viz., the rule of alternation or of contrasted gametes.

T. H. MORGAN.

RECENT CHANGE OF LEVEL IN ALASKA.[1]

ABOUT the middle of September, 1899, the coast of Alaska, in the St. Elias-Fairweather region, was visited by a series of vigorous earthquake shocks, one effect of which was to greatly modify the front of the Muir glacier, and to fill Muir Inlet with ice dislodged from the glacier. The shocks were also felt with marked intensity at Yakutat, and a company of prospectors, camped near the Hubbard glacier in Disenchantment Bay, report a series of severe shocks and accompanying water waves.

[1] The observations outlined in this paper were made in the summer of 1905 in connection with a general geological survey of the Yakutat Bay region by a United States Geological Survey party under the direction of the senior author. A grant of money obtained through the assistance of the American Geographical Society made it possible to add the junior author to the party as special assistant in physiographic and glacial geology. Acknowledgments are due to B. S. Butler, the other member of the party, for assistance in this work. Published by permission of the Director of the U. S. Geological Survey.

During our work along the shores of Yakutat Bay, and its extension called Disenchantment Bay and Russell Fiord, abundant evidence was found to prove that the shores of the great fiord suffered a profound disturbance during this earthquake. The evidences of change of level are: (1) physiographic—elevated rock benches, sea caves, chasms, alluvial fans and beaches, submarine till uplifted to form shore lines, and the appearance of new reefs and islands; (2) biological—various marine forms, such as *Balanus, Mytilus* and a calcareous alga clinging to uplifted rock on which land plants now thrive, but in no case plants more than five years in age; and (3) human—the narrative of the Yakutat natives. Depression is shown by the sea encroaching on and killing trees; and extensive water waves are proved by the destruction of forests along the shores of Yakutat Bay high above the present reach of the waves.

The fiord, which is about sixty miles in length, has the form of a bent arm, starting from the Pacific as the broad Yakutat Bay. This bay is bordered by a low foreland of glacial debris on the southeast and by Malaspina glacier, with its fringe of glacial debris, on the west.

Back of the lowland fringe rises a range of mountains, really foothills of the St. Elias chain, reaching elevations of from 4,000 to 6,000 feet. The seaward face of this range rises abruptly out of the low foreland with a steep and remarkably straight front. Into this range Yakutat Bay penetrates, rapidly narrowing to the form of a fiord whose lower end is named Disenchantment Bay. At the head of this bay the fiord, thence called Russell Fiord, abruptly turns back toward the ocean and extends out beyond the steep mountain front, ending in a bay-like expansion in the fringing lowland. Three large tidal glaciers—Hubbard, Turner and Nunatak—fed among the lofty mountains of the St. Elias chain, enter the fiord.

The mountainous shores of the fiord have been differentially deformed, some parts showing no change in level, while one shore, that south of Turner glacier, has suffered elevation of from 33 to 47 feet. Accompanying this change there has evidently been faulting along some of the arms of the fiord. That this faulting has been complex is indicated by the presence, in a number of places on the land, of numerous new faults close together and parallel to each other and, in general, to the strike of the St. Elias chain. The best of these were observed on the nunatak at Nunatak glacier, where the maximum throw of single faults reached three feet, though the aggregate throw of all the faults in a given region amounted to several times this figure. The region has apparently been warped and broken into a series of blocks which are tilted in a complex relation, and which themselves have suffered extensive minor faulting. In one place, along the lower part of Russell Fiord, the faulting apparently follows a line of earlier movement.

The uplift is confined to that part of the region which lies along and inside of the steep, straight mountain front, while on the low fringe of foreland, and in the Malaspina glacier region, there is, for the most part, no evidence of any change of level excepting at the very mountain base. Locally, however, and especially near the mountain, there is depression along the shores of the lowland, reaching a maximum of from three to five feet. Professor Russell long ago assigned to this mountain front a fault origin on the basis of the form, and our observations confirm this interpretation. Moreover, there is clear evidence of a still earlier, though very recent, movement along this major fault line.

Our observations, which later will be published in full, indicate that the earthquake was the result of a great upward movement along the front of the St. Elias chain, with minor differential movements of large and small kind, together complexly fracturing the crust along and near the shores of the fiord. Along the extreme front of the mountains the uplift was from six to nine feet; but further back it locally reached a much greater figure, in one place, as previously stated, causing an uplift of the coast of 47 feet.

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BOTANICAL NOTES.

THE AMERICAN BREEDERS' ASSOCIATION.

A COUPLE of years ago, a number of botanists and zoologists joined interests with a number of practical growers of plants and animals and effected an organization of a new society under the name of 'The American Breeders' Association.' The purpose, as set forth in the constitution, adopted at St. Louis, December 29, 1903, is 'to study the laws of breeding and to promote the improvement of plants and animals by the development of expert methods of breeding.' With this object in view, about seven hundred members have been enrolled. These are, naturally, quite largely drawn from the ranks of practical breeders, but there are many scientific men also, and it is notable that the officers of the association have been very largely chosen from the professors in universities and colleges, and the scientific experts in the service of the United States Department of Agriculture.

Two meetings have been held, the first in St. Louis, December, 1903, and the second in Champaign, Illinois, February, 1905. In the first, seventeen papers were read, fully half of which possess more or less interest to the botanist. In the second meeting, twenty-eight papers were presented, with a still larger preponderance of papers relating to plant breeding. Among the papers of especial interest to botanists may be noted one by Professor DeVries on 'Investigations into the Heredity of Sporting Varieties,' another by Doctor Webber on 'Cotton Breeding,' one by W. A. Orton on 'Plant Breeding as a Factor in Controlling Plant Diseases,' one by Professor Hansen on 'Breeding Mildew-resistant Sand Cherries and Roses' and one by Dr. George T. Moore on 'Breeding Bacteria.' Other titles equally suggestive to the botanist might be cited, but these will show what the approaching meeting in Lincoln, January 17, 18 and 19, is likely to include. The program for this meeting is now being made out. It is understood that, in addition to general sessions of the association, there will be joint sessions with the State Horticultural Society, Corn Growers' Association, Live Stock and Dairymen's associations. The secretary is Professor W. M. Hays (assistant secretary of agriculture), Washington, D. C.

METHODS IN PLANT HISTOLOGY.

A LITTLE more than four years ago, the first edition of Dr. Chamberlain's 'Methods in Plant Histology' was noticed in these columns (SCIENCE, August 16, 1901). Now a second edition has appeared, much improved and considerably enlarged. In it so much new matter has been incorporated that the book is in fact a new one and must wholly replace the first edition. The extent of the enlargement may be estimated from the fact that, while the first edition contained 159 pages and 74 figures, the second contains 262 pages and 88 figures. Many new methods of work are described in this edition which were but briefly referred to, or were wholly omitted from the first. In the systematic part of the book many more suggestions as to collecting and growing material are given, thus greatly increasing its practical value. This edition must prove to be even more useful to botanical workers in high school, college and university laboratories than its predecessor.

FERNS OF THE PHILIPPINE ISLANDS.

DR. E. B. COPELAND has recently made an important addition to our knowledge of the flora of the Philippines by the publication of a descriptive list of the orders of ferns (*Polypodiaceae*) occurring in the islands. It appears as Bulletin 28 of the government laboratories at Manila, bearing date of July, 1905, and covers 139 octavo pages. The general nature of the fern flora as far as represented in this booklet may be understood from the following analysis. There are eight families represented, as follows: *Woodsieae* (with 1 genus, and 1 species); *Aspidieae* (9 genera, 117 species); *Davallieae* (12 genera, 72 species); *Asplenieae* (12 genera, 91 species); *Pterideae* (11 genera, 44 species); *Vittarieae* (3 genera, 14 species); *Polypodieae* (10 genera, 99 species); *Achrostichieae* (4 genera, 7 species). The largest genera are *Nephrodium* (with 60 species), *Lindsaya* (with 22 species), *Asplenium* (with 36 species), and

Polypodium (with 73 species). Two species of the interesting and curious 'staghorn ferns' (*Platycerium grande* and *P. biforme*) occur on the islands.

SOME NOTEWORTHY BULLETINS.

PROFESSOR B. M. DUGGAR's paper on 'The Principles of Mushroom Growing and Mushroom Spawn Making' has been issued as Bulletin 85 of the Bureau of Plant Industry, of the United States Department of Agriculture. It covers sixty pages and includes seven halftone plates. It will be useful to botanists and especially so to the growers of mushrooms.—Bulletin 84 of the Bureau of Plant Industry, entitled 'The Seeds of the Bluegrasses,' contains a paper by Edgar Brown on the germination, growing, handling and adulteration of bluegrass seeds, and another by F. H. Hillman, consisting of descriptions of the seeds of the commercial bluegrasses, and their impurities. Illustrations in the text add much to the value of the bulletin.—O. F. Cook and W. T. Swingle discuss the 'Evolution of Cellular Structures' in Bulletin 81 of the Bureau of Plant Industry. It is a discussion of the mode of evolution, and lays particular emphasis upon *symbasis,* that is, diversity of descent with normal interbreeding. They say 'species are sexual phenomena; they have come where they are only through symbasis; that is, as groups of interbreeding individuals, traveling together along the evolutionary pathway.'—From the same bureau, we have in Bulletin 90, part II., a short paper by G. G. Hedgcock on 'The Crown-Gall and Hairy-root Diseases of the Apple Tree,' in which the author separates the two, establishes the non-contagious nature of the first, says that there is no proof that the second is contagious, and shows by experiments that the first affects the growth of the tree little if any. The paper is in the nature of a report of progress and is very suggestive to plant pathologists and practical orchardists.—Bulletin 64 of the Forest Service, by Raphael Zon, deals with the characteristics, growth, distribution and uses of the loblolly pine (*Pinus taeda*) in eastern Texas. Especial attention is given to its use in the production of railway ties.—In Bulletin 28 of the Bureau of Soils, B. E. Livingston, J. C. Britton and F. R. Reid give the results of their 'Studies on the Properties of an Unproductive Soil,' and reach the rather startling conclusion that the particular soil studied (at Takoma Park, Md.) 'contains a water-soluble, non-volatile substance or substances, probably organic in nature, which are toxic to wheat plants, causing a stunting of their growth.'—From the United States National Herbarium we have (Vol. VIII., pt. 4) the fourth of a series of 'Studies of Mexican and Central American Plants' by Dr. J. N. Rose, the result of a fourth journey to Mexico, made by the author. It contains many descriptions of new species, and critical notes upon old ones. It is illustrated by ten plates and six text figures.

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CURRENT NOTES ON METEOROLOGY.

KITE-FLYING OVER THE TROPICAL OCEANS.

REFERENCE has frequently been made in SCIENCE during the past two or three years to the project for exploring the atmosphere over the tropical oceans by means of kites, suggested by Mr. A. Lawrence Rotch, of Blue Hill Observatory, in 1901. It is pleasant to be able to chronicle, in these notes, the successful ending of a preliminary expedition undertaken during the past summer under the joint auspices of Mr. Rotch and of Mons. L. Teisserenc de Bort. Preliminary reports have appeared in the *Comptes Rendus,* October 9, 1905, 'Sur les Preuves de l'Existence du Contre-Alizé,' by Rotch and de Bort, and in *Nature,* November 16, 1905, 'The Exploration of the Atmosphere over the Tropical Oceans,' by the same authors. One of the chief objects of the expedition was to study the anti-trade winds from the southwest, which, according to a report by Dr. Hergesell, based on his observations in 1904, do not exist. The work last summer was done on board the *Otaria,* a steamer equipped with an electric kite-reel already used by de Bort for kite-flying at sea. Messrs. Clayton, of Blue Hill, and Maurice, assistant at the observatory at Trappes, carried out the exploration.

Paper pilot balloons, to show wind directions and not carrying instruments, were sent up and their height was obtained by simultaneous angular measurements at the end of a base-line on shore. Soundings of this kind were made at Madeira, Teneriffe and the Cape Verde Islands in particular, and also over the open ocean. Observations were also made on the peaks of Teneriffe and Togo, and included the drift of clouds above these peaks. Tabulations of these observations, and a chart showing the tracks of three balloons, make it evident that the winds blowing equatorward vary in direction between northeast and northwest. The latter are usually above the northeast stratum, the thickness of this layer of the trades near Teneriffe being about 3,000 or 5,000 meters. Above this there are southeast, south and southwest currents—the anti-trades—of great thickness, probably, but of small density. The east wind near the thermal equator extends very high, as had previously been inferred from the carriage of volcanic dust and the movements of lofty clouds. The southeast wind was observed by a balloon at the Cape Verde Islands up as far as 6.8 miles.

The results obtained during the past summer, therefore, confirm the accepted theory of trades and anti-trades, and are not in accord with the view advanced by Dr. Hergesell. North of Madeira and towards the Azores the upper winds, as already shown by cloud observations, are prevailingly from west and northwest, this region being usually north of the oceanic high pressure area and outside the trade wind zone. The anti-trades, with their southerly component, are generally southwest in the latitude of the Canary Islands and southeast near the Cape Verde Islands, corresponding to the effects of the earth's rotation. Upper cloud observations at Havana and in the Antilles further prove the existence of these winds.

AN INSTRUMENT FOR DETERMINING TRUE WIND DIRECTIONS AND VELOCITIES AT SEA.

IN the 'Report of the Imperial Academy of Sciences of St. Petersburg' for August, 1905, Mr. Rotch describes an instrument of his own invention which is designed to give the true wind direction and velocity on a moving vessel at sea, an observation which has always been difficult and troublesome. The theory of this instrument is based on the triangle of forces. It consists of two movable discs, graduated into 360° each, and three rulers, hinged so that they may be adjusted to different angles. One of these rulers indicates the direction in which the vessel moves; a second shows the apparent, and the third the true wind direction. To set the instrument the direction of movement and the speed of the vessel; the apparent wind direction, shown by the smoke from the funnel, and the true wind direction shown by the waves, are needed. When the rulers are set to accord with these conditions, the true wind direction, in degrees, and the true wind velocity, in miles an hour, are shown by means of the discs above referred to.

Casella, of London, is the maker of the instrument, the price of which is approximately £3.

BRITISH RAINFALL, 1904.

THE forty-fourth annual volume on 'British Rainfall,' compiled by Dr. H. R. Mill, includes the records of 3,982 rain gauges. In his preface the compiler regrets that he can not visit more of the stations, and notes that the chief difficulty is the inadequate train service in the rural districts. The effect of the automobile's advent is noted in the statement that 'a few years ago the bicycle supplied a quick and easy means of overcoming the difficulty, but now, except for the fact that it is not prohibited by law, cycling on the high roads of England scarcely differs in point of danger from walking on the railways.' The volume contains an appreciative mention of the valuable work done at Ben Nevis Observatory since 1883, and now unfortunately given up, and the frontispiece shows the summit of the mountain in winter. There are other papers on subjects of more local British interest, but we call attention with special satisfaction to the charts showing the tracks of cyclones which produced exceptionally heavy rainfalls during the year 1904, the same charts showing also the distribution of the

rainfall. This is an emphasis on the cyclonic unit which we have long hoped to see.

R. DEC. WARD.

SOME STATE CENSUS FIGURES FOR 1905.

THE state censuses for 1905 are showing some instructive returns. Iowa, for instance, shows a loss of 15,000 persons since 1900. The cities of 5,000 population and over gained 77,000 people in all; the towns under 5,000 and the rural districts together report a loss of 92,000. In Minnesota, where the gain during the decade, 1890 to 1899, inclusive, was 33.7 per cent., there has apparently been a slowing up. The decennial rate was 3.37 per cent. a year; but for the past five years, 1900 to 1905, there was a gain of only 13 per cent., or 2.6 per cent. a year. As the basis broadens the rate of accretion necessarily becomes slower, while in Iowa the rate indicates even retrogression. The indications are that, either from urban migration or from other causes, or from all combined, the farming population even in the most prosperous portions of the west has practically ceased to grow.

One reason for this, if the view of arrested growth be accepted, is to be found in the rapidly rising price of farming land. For the past several years or more the trend of prices of land has gone upward with the prices of farm produce. Iowa, being a dairying and stock-growing state, has come to put such values upon her farm lands as to dislodge the old style of farming for a family home, in favor of the capitalistic farmer—the farmer who puts surplus income back into land, into better methods of cultivation, better stock and better facilities. The old-style farmer moves off to Canada for frontier lands, or to the southwest or northwest, where land is cheaper, after having reaped the reward of waiting, in the form of the unearned increment.

Kansas took her fifth decennial census on March 1, 1905, and found the insignificant increase of 8,658 persons in one year, the total population being 1,543,868. This gives an average of 14,703 people for each of the 105 counties. Of these counties 58 report an increase, and 47 a decrease, compared with March 1, 1904. The highest increase is 2,987 persons out of a total of 48,058, or 6.6 per cent. gain in one year. The largest decline is one of 2,087 persons, leaving a population of 24,907, or 9.1 per cent. less than a year earlier. These are marked changes to occur in so small a population in the course of twelve months from ordinary causes in times of prosperity in city and country alike.

Turning from country to city, we see that in Kansas towns the same shifting is going on. One might think that towns have been the gainers of country losses; but this is not always the case. The changes are due to a wider range of influences than urban attraction. Of 119 cities of a thousand inhabitants and over, 61 gained in the last year and 58 lost in numbers. Only four gained over one thousand each, and five of the cities lost each a thousand or over; but none so much as two thousand. While these are small numbers, they indicate the presence of some active influences which are responsible for a great deal of readjustment. Kansas is eminently the commonwealth of comparatively small towns. How emphatically this is the case is apparent from the following table of towns of 1,000 people and over, which may or may not suggest some explanation of the gain and loss account within its borders:

No. of Towns.	Range of Population.
4	have each from 20,924 to 67,613 inhabitants.
8	have each from 11,190 to 18,257 inhabitants.
12	have each from 5,188 to 9,899 inhabitants.
40	have each from 2,013 to 4,427 inhabitants.
55	have each from 1,009 to 1,998 inhabitants.

Any attempt to trace these evidences of arrest in increase, or of decrease, to unfavorable agricultural conditions must fail; because the same tendency appears in manufacturing states. For instance, Massachusetts, which is more than half cities or towns of over 5,000, has a disappointing return in its census for 1905. Taking into account the increase in the previous decade, a growth in population of 375,000 was expected and predicted. The actual increase is 193,612, barely half the expected gain.

The rate of increase, 6.9 per cent., is half that for twenty years back. It was 7.9 per cent., 1875 to 1880; and 8.9 per cent., 1880 to 1885; but this is the only time it has ever been as low; and of the earlier decade, the first five years, 1875 to 1880, were years of great financial depression.

The past five years have been years of overflowing prosperity. Yet the increase in population in Massachusetts drops to one half the earlier rate. The addition to population in the latest five years is no larger than it was thirty years ago, when the inhabitants of the states numbered only half as many as now.

"This same arrest of population," says the Philadelphia *Press,* "is in progress all over the country. No state is likely to show in this decade the increase of the past. Our national increase, which has been jogging along at about 25 per cent., in ten years, is about to make a drop to 12 or 15 per cent. in ten years, a little above the average of thriving European countries like Germany and England."

JOHN FRANKLIN CROWELL.

WASHINGTON, D. C.

THE MUSEUMS ASSOCIATION OF AMERICA.

AN informal meeting of a few of the administrative heads of some of the greater museums of America was held at the United States National Museum in Washington on December 21. There were present Dr. Richard Rathbun, the director of the National Museum, Dr. H. C. Bumpus, director of the American Museum of Natural History, New York, Dr. N. L. Britton, the director of the New York Botanical Garden, Dr. F. A. Lucas, the curator-in-chief of the Brooklyn Institute, Dr. W J McGee, the director of the St. Louis Public Museum, Dr. W. P. Wilson, the director of the Philadelphia Museums, and Dr. W. J. Holland, the director of the Carnegie Museum. Dr. Samuel Henshaw, the curator of the Cambridge Museum of Comparative Zoology, and Dr. F. J. V. Skiff, of the Field Museum of Natural History in Chicago, were not present, but were represented by letter.

The meeting had been called for the purpose of considering whether it might be advisable to take preliminary steps looking toward the organization in America of a Museums Association somewhat analogous to that which exists in Great Britain. It was finally unanimously decided that the gentlemen represented in this informal gathering should over their names issue a call to the representatives of a number of the larger and more important museums of the United States to convene for the purpose of organizing The Museums Association of America.

In the informal discussion which took place it was decided that the movement should not be restricted to natural history museums, but that museums representing art, as well as the sciences, should be included in the call, and that the invitations should be made to cover the institutions of America, using the word in its widest sense, so as to include all of North America and South America and the various insular possessions of the United States and Great Britain in the western hemisphere.

In accordance with a resolution adopted invitations to attend a preliminary gathering for the purpose of organizing The Museums Association of America will shortly be issued to a number of institutions and individuals who are thought to be likely to be interested in such a movement. This conference will be held at the American Museum of Natural History in New York on May 15, 1906.

PITTSBURGH, PA.,
December 23, 1905.

SCIENTIFIC NOTES AND NEWS.

THE New Orleans meeting of the American Association for the Advancement of Science and the societies affiliated with it begins today. This evening Professor W. G. Farlow, of Harvard University, will give the presidential address, his subject being 'The Popular Conception of the Scientific Man at the Present Day.' We hope to publish this address next week.

THE Paris Academy of Sciences has awarded the Lalande prize to Professor William Henry Pickering, of Harvard University, for his discovery of the ninth and tenth satellites of Saturn.

DR. WILLIAM H. WELCH, professor of pathology in the Johns Hopkins University, has been elected a trustee of the Carnegie Institution of Washington, to fill the vacancy caused by the death of John Hay.

PROFESSOR F. E. LLOYD, of Teachers College, Columbia University, has accepted the position of resident investigator at the Desert Botanical Laboratory of the Carnegie Institution, at Tucson, Arizona.

DR. PEHR OLSSON-SEFFER, for the past two years instructor in botany in Stanford University, has been selected to take charge of a botanical station in tropical Mexico for the investigation of problems connected with the cultivation of rubber and coffee. The station is established by the Hidalgo and La Zacualpa Companies, which own twelve large plantations in the region in question devoted to the raising of rubber and coffee.

PROFESSOR HAROLD HEATH, associate professor of zoology in Stanford University, will be absent from the university during the coming semester on sabbatical leave. He will occupy the Smithsonian table at the Naples Aquarium for two months, visiting Egypt, India and spending two months in Japan, returning to take up his work September, 1906.

DR. L. RADLKOFER, professor of botany at Munich, has celebrated the fiftieth anniversary of his doctorate.

SIR WILLIAM THISELTON-DYER, whose resignation of the post of director of the Royal Botanic Gardens at Kew we announced last week has held that appointment since 1885, and for ten years—1875–1885—before his promotion he was assistant director. His successor, Lieutenant-Colonel David Prain, had a distinguished university career at Aberdeen and Edinburgh before he entered the Indian Medical Service in 1884. Three years after his arrival in India he was nominated curator of the Calcutta Herbarium; in 1895 he became professor of botany at the Medical College, Calcutta, and superintendent of the Royal Botanic Garden there, and in 1898 he was appointed director of the Botanical Survey of India. He is forty-eight years of age.

DR. RICHARD HODGSON, secretary of the American Branch of the American Society for Psychical Research, died suddenly at Boston on December 20.

PROFESSOR HEINRICH MEININGER, formerly professor of technical physics, at Karlsruhe, has died at the age of eighty-four years.

WE are requested to state that owing to a strike in the printing office at Easton, Pa., the issue of the December number of the *Journal of the American Chemical Society* has been delayed, and the issue of that journal and of the *American Chemical Journal* for January will also be delayed.

THE engineering students of Washington and Lee University met on December 4 for the purpose of organizing a local scientific society. Addresses were made by Professors Stevens, Humphreys, Campbell and Howe.

THE council of the Iron and Steel Institute has arranged that the annual general meeting of the institute shall be held in London on May 10 and 11, 1906. In place of the usual autumn meeting, a joint meeting with the American Institute of Mining Engineers will be held in London on July 23 to 28. It is intended during the week following to give the American visitors an opportunity of seeing some of the ironmaking districts. It is anticipated that the visiting party will include many of the leading ironmasters who entertained the Iron and Steel Institute in America in 1890 and 1904. The Lord Mayor has consented to act as chairman of the London reception committee, and to give an evening reception at the Mansion-house.

THE sixth International Congress of Criminal Anthropology will open at Turin on April 28, 1906. The following questions are proposed for discussion, and the communications presented will, as far as possible, be grouped round these as central themes: (1) the treatment of juvenile criminality according to the principles of criminal anthropology, to be introduced by M. von Hamel; (2) the treatment of female criminality, to be introduced by Dr. Pauline Tarnowsky; (3) the relations of economic conditions to criminality, to be introduced by Professor Kurella; (4) the

equivalence of the various forms of sexual psychopathies and criminality, to be introduced by Professor C. Lombroso; (5) criminal anthropology in police organization, to be introduced by Professor Ottolenghi; (6) the psychological value of evidence, to be introduced by Dr. Brusa; (7) prophylaxis and treatment of crime, to be introduced by Dr. Ferri; (8) establishments for the perpétual detention of criminals declared to be irresponsible on account of mental defect, to be introduced by Professor Garofalo.

THE New Haven correspondent of the N. Y. *Evening Post* states that a collection of Central American antiquities, the value of which was not suspected, has just been brought to light in the Peabody Museum and, when arranged, will be put on exhibition in the anthropological department. Beginning as early as 1860, A. De Zeltner, French consul at Panama, and Mr. J. E. McNeil, for many years a resident of Panama, collected in that province antiquities of the Chiriqui Indians, who ranked next in culture to the Aztecs and to the Peruvians under the Incas. The collections, chiefly secured from prehistoric graves, were brought down from the interior on horses, but, as the result shows, with only slight breakages. The late Professor O. C. Marsh bought the collections from time to time, and down to the year 1879, storing the boxes away in a remote part of the museum building, where they have remained unopened for twenty-six years.

MR. CHARLES S. SPANG, formerly of Pittsburg, who recently died in Paris, where he spent the latter half of his long life, before his death requested his heirs to turn over to the Carnegie Museum his collection of Etruscan pottery and Egyptian antiquities. In accordance with his wish these collections have come into the custody of the museum. The collections were made nearly fifty years ago by a gentleman whom Mr. Spang employed to make excavations, and the specimens are remarkably fine and such as could not well be obtained to-day.

DR. ZAMBACO PACHA has devoted the sum of 10,000 francs towards the organization of a medical congress to be held every three years at Athens.

THE liabilities of the Royal Botanical Society of London now exceed £30,000. It is proposed to increase the dues from two to three guineas.

AN Association of Municipal Engineers, Architects and Hygienists of France, Belgium and Switzerland held its first meeting in Paris from November 22 to 25.

THE New York Academy of Medicine announces that the Edward N. Gibbs memorial prize, of the value of $1,000, will be awarded to the author of the best essay on 'The Etiology, Pathology and Treatment of Diseases of the Kidney.' Essays must be received on or before January 1, 1907, by the recording secretary at 17 West Forty-third Street, New York City.

THE Senckenburg Natural History Society at Frankfort offers a prize of 1,000 Marks for a research on the paleontology of the region about Coblentz and Ems.

THE *British Medical Journal* states that the trustees of the Pilkington Cancer Research Fund are about to appoint a graduate in medicine, or other qualified person, to carry out a research into the cause, prevention and cure of cancer, under the supervision of the professors of general pathology and of systematic surgery in the Victoria University of Manchester (Professor Lorrain Smith and Professor G. A. Wright). The appointment will be for one year, but may be renewed for a further period of one or two years, and the holder of the post will receive an income of £300 per annum with a grant for laboratory expenses.

ACCORDING to *Nature* an archeological museum, which will devote special attention to Indo-Chinese matters, has been established by the French government at Pnompenh. The museum will be under the scientific control of the Ecole française d'Extrême-Orient, the chief of the archeological department of which school will act as director of the new museum.

ACCORDING to the statistics collected by Mr. Waldemar Lindgren for the U. S. Geological

Survey, the production of gold in the United States during 1904 amounted to 3,910,729 fine ounces, valued at $80,835,648. This represents an increase of $7,243,948 over the production of 1903. After a period of very rapid advance in the gold production from 1892 to 1900, during which an increase from $33,000,000 to $79,171,000 took place, there followed two years of nearly stationary output and one year, 1903, of very decided decrease. It is, therefore, very gratifying to find that the production has risen again with a bound to record figures, the largest previous output in 1902, amounting to $80,000,000. The production of silver in 1904 amounted to 55,999,864 fine ounces, valued at $32,035,378. This represents an increase of 1,699,864 ounces over the production of 1903, and an increase in value of $2,713,378. There is, therefore, a total increase of $9,957,326 in the value of gold and silver produced in 1904 over that of 1903. The record output of silver in 1892, amounting to 63,500,000 fine ounces, has not been reached in late years, nor has the commercial value attained the figures of that year, which amounted to $82,101,000. The price of silver in 1904, according to the director of the mint, varied from 55 to 61 cents per fine ounce, representing a decided increase over the prices of 1903, which varied from 48 to 59 cents and only exceptionally rose to 61 cents in October, 1903.

UNIVERSITY AND EDUCATIONAL NEWS.

THE council of Columbia University has adopted resolutions as follows:

Resolved, (1) That in the opinion of the University council the present game of football should be prohibited at Columbia University and the council recommends that the president take immediate action to that end.

(2) That the president be advised to take such further steps as may seem to him proper to correct the conditions at Columbia, which have produced the demoralization of sentiment above referred to and to restore the athletics to their proper place in the life of the university, with the view,

(*a*) Of encouraging the widest possible participation of the student body in athletic sports, instead of leaving them, as at present, in the hands of a small class of trained athletes.

(*b*) Of substituting, as far as possible, competition in sports among the students at Columbia in the place of intercollegiate competitions, and of restricting the latter, with the exception of rowing, as far as possible, to the home grounds of the Columbia teams.

(*c*) Of eliminating the professional aspects of athletic sports by reducing to a minimum the time devoted to training and by placing the sports and the training therefor under the immediate direction of the university authorities.

(*d*) Of suppressing the commercialism attendant on intercollegiate competitions in certain sports by a radical reduction of expenses and the elimination of gate receipts.

AT a meeting of the presidents of the two California universities with the committee on athletics of each institution held recently in San Francisco the following action was taken:

Resolved, by the joint athletic committees of the University of California and the Leland Stanford Junior University, that we recommend to the faculties of the two universities in question that the intercollegiate football contest shall be no longer held under the regulations of the present football rules committee. We recommend as a substitute the present English Rugby game, or else the present American game with such modifications as shall promise to eliminate the existing evils.

A committee of men prominent as coaches and players of the game from among the alumni of the two institutions was selected to work with the faculty committees in framing a final decision in the matter.

DR. HENRY T. EDDY, professor of engineering and mechanics in the University of Minnesota, has been elected dean of the Graduate School at that university; and Dr. George F. James, professor of pedagogy, has been elected dean of the School of Education, just established.

PROFESSOR SIMON J. MCLEAN, for three years associate professor of economics and acting head of the department in Stanford University, has accepted a call to a chair in his *alma mater*, Toronto University, and will take up his duties there in January.

JAS. R. WITHROW, Ph.D. (Pennsylvania), has accepted an instructorship in chemistry in the University of Illinois.